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A MONOGRAPH
ON THE
BRITISH FOSSIL
ECHINODERMATA

FROM
THE CRETACEOUS FORMATIONS.

BY
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PART FIRST.
ON THE CIDARIDÆ.

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A MONOGRAPH

ON THE

CRETACEOUS ECHINODERMATA.

ON THE CRETACEOUS GROUP.

THE Cretaceous group, as a whole, as developed in England, has been so fully described by Conybeare and Phillips,¹ and its subdivisions by other authors,² that it appears to be unnecessary to devote any great space to this branch of the subject, beyond an epitomized outline of the subdivisions of the Cretaceous rocks, with brief notes on the species of *Echinidæ* found therein, and the co-relation of these stages with their equivalent zones of life in the Cretaceous systems of the Continent of Europe; and as the Isle of Wight exhibits some of the best coast-sections of the Cretaceous rocks in the British

¹ The 'Outlines of the Geology of England and Wales' contains a most able account of this formation.

² The following, among many others, may be consulted for important information on the Cretaceous formation:—Dr. Fitton's various memoirs in the 'Geol. Transactions,' and 'Quarterly Journal of the Geol. Soc.;' Sir H. De La Beche, "On the Chalk and Greensand of Lyme Regis," 'Geol. Trans.,' vol. ii; Young and Bird and Professor John Phillips on the Geology of Yorkshire; Dr. Mantell's works on the Geology of Sussex; Samuel Woodward's 'Geology of Norfolk;' Dixon's 'Geology of Sussex.' The various memoirs in the 'Quarterly Journal of the Geol. Soc.' on the Cretaceous Rocks, by Professor E. Forbes, Messrs. Lonsdale, Rose, Austen, Cunningham, Morris, Weaver, Rose, Clarke, Bunbury, Bowerbank, R. C. Taylor, Ibbetson, Toulmin Smith, D. Sharpe. The Manuals of Geology, by Sir H. De La Beche, Sir Charles Lyell, and Professor Jukes; and the "Geology of the Isle of Wight," by Mr. H. W. Bristow, in the 'Memoirs of the Geological Survey.' The reader will likewise find most valuable information in Le Vicomte D'Archiac's 'Histoire des Progrès de la Géologie,' tom. iv and v, "Sur la Formation Crétacée;" the memoirs by M. E. Guéranger, in the 'Bull. Soc. Géol. de France;' M. Cornuel's "Section of the Environs of Vassy" ('Mém. Soc. Géol. de France,' t. iv); M. Leymerie's "Mém. on the Department of the Aube" ('Mém. Soc. Géol. de France,' t. iv and v); and in the different important works by the late M. Alcide d'Orbigny.

Islands, in their stratigraphical order of superposition, I shall take these as a type of the whole, supplying any deficiency in the series by examples afforded by other localities.

THE LOWER GREENSAND.

The Lower Greensand, occupies an extensive tract in the southern part of the Isle of Wight, where it attains a thickness of nearly 900 feet; this great formation has been so carefully examined and well described by the late Dr. Fitton,¹ in his stratigraphical account of the section from Atherfield to Rocken End, on the south-west coast of the island, that I must refer the reader for full information to that valuable memoir for further details. Having worked several times over all the beds of that remarkable and most instructive district, and in my excursions had the advantage of the local knowledge and assistance of Dr. Fitton's collector and guide,² I shall now merely attempt a generalized account of this section, for the purpose of pointing out the beds with which we are more immediately interested, in our description of the Echinidæ contained therein.

The entire series of the Lower Greensand beds, 809 feet in thickness, rise in succession from the shore and ascend into the cliffs between Atherfield Point and Rocken End, towards which they dip at an inclination of about 2°.

The following Subdivision of the Atherfield Section was proposed by Dr. Fitton, in ascending order.

	Feet.	Inches.
I. Perna Mulleti Bed	5	3
II. Atherfield Clay	60	0
III. The Cracker Rocks.....	85	0
IV. The Lower Gryphæa Group	32	0
V. Scaphites Group	50	4
VI. Lower Crioceras Group	16	3
VII. Walpen Clays and Sands	57	0
VIII. Upper Crioceras Group	46	2
IX. Walpen and Ladder Sands	42	0
X. Upper Gryphæa Group	16	0
XI. Cliff-End Sands	20	0
XII. Foliated Clay and Sand.....	25	0
XIII. Sands of Walpen and Black-Gang Undercliff	97	0
XIV. Ferruginous Sands of Black-Gang Chine.....	20	6
XV. Upper Clays and Sand-Rock.....	118	0
XVI. Various Sands and Clays	118	4
	808	10

¹ "A Stratigraphical Account of the Section from Atherfield to Rocken End, in the South-west Coast of the Isle of Wight," 'Jour. of the Geol. Soc.' vol. iii, p. 289, 1847.

² Mr. Charles Wheeler, fisherman, at Ventnor, is the person alluded to, he has a most correct knowledge of the range and position of all the beds, and of their fossil contents, and is a most trustworthy guide to the Atherfield Section.

I. *The Perna beds*, which here form the base of the Lower Greensand, rest upon Weald clay; the junction between the lacustrine series of the latter with the marine deposits of the former exhibit no trace of disturbance; a thin seam of bone-bed, composed of the teeth of fish of lacustrine species, attest a change of conditions similar to that observed in some junction-beds in other formations, as between the Upper Keuper and the Lias, and the Upper Silurian and Devonian series. This junction, which is only sometimes visible, occupies about eight inches of vertical thickness; on one occasion I succeeded in detaching a block of rock, about a foot thick, from the beds, the lower half of which contained the lacustrine shells of the Weald clay, whilst in the upper half *Perna Mulleti*, Desh., *Exogyra sinuata*, Sow., and other Lower Greensand shells, were found. The *Perna* beds rise from the base of the cliff, at a point a few yards to the east of the flag-staff of the coastguard-station; they consist of dark-blue sandy clay and greenish sand, forming in parts a very hard rock, and characterized by that remarkable shell *Perna Mulleti*, Desh., which is not found in any other bed in the section. Nearly one hundred species of marine shells are found in the *Perna* beds; among these *Nautilus Requinianus*, d'Orb., and *Exogyra sinuata*, Sow., appear for the first time, of very large size, and *Hemipneustes Fittonii*, Forb., among the Echinida, with the remains of fish belonging to the genera *Lamna*, *Odontaspis*, *Saurocephalus*, *Hybodus*, &c.

II. *The Atherfield Clay* is of a drab colour, passing into bluish-gray, and contains flat nodular masses. *Ammonites Deshayesii*, Leym., *Pinna Robinaldina*, d'Orb., and several other species of Conchifera, with the bones of a Turtle, and the remains of Echinidæ, are found in this bed.

III. *The Crackers*, so called from the noise produced by the waves dashing over the ledges formed by these rocks on the shore, are the most interesting fossiliferous group of the entire series, and consist of alternations of sandy clays and clays, and two layers of ferruginous sandy nodules. All the clays resemble Fullers' earth, and the sand between the nodular concretions in the lower bed is sometimes indurated into an imperfect stone. The lower part of this group is a brown clay and sand, called the Lower Lobster bed, from the number of *Astacus Vectensis*, Bell, found therein; the succeeding beds are sands, containing concretionary masses of sandstone full of beautiful fossil shells, *Ammonites Deshayesii*, Leym., *Pholadomya Martini*, Forb., *Myacites plicata*, Sow., *Corbula striatula*, Sow., and several other Conchifera. Many of the *Myadæ* are found in the upright position they assumed during life. The lower sandstone, from a foot to eighteen inches in thickness, is almost entirely made up of *Gervillia aviculoides*, Sow., *Trigonia Dædalæa*, Park., *Ammonites Deshayesii*, Leym., and other shells. The upper layer of sandstone contains coniferous wood and a *Teredo*, and the upper clays are fossiliferous throughout. In the concretionary nodules of the lower series of this group I have collected *Pseudodiadema Autissodorensis*, Cott., *P. Ibbetsoni*, Forb., and *Hemipneustes Fittoni*, Forb., with the

beautiful winged shells *Rostellaria glabra*, Forb., *R. retusa*, Sow., *Pterocera Fittoni*, Forb., and several species of Cerithia, as *Cerithium turriculatum*, Forb., *C. Neocomiense*, d'Orb., and *C. Phillipsi*, Leym.

IV. *The Lower Gryphæa or Exogyra Group* has for its base a thick bed of ferruginous sand, overlain by sand containing *Perna alæformis*, Sow., and *Terebratula sella*, Sow., in great abundance, in thin seams of sand. The zones with *Exogyra sinuata*, Sow., which here are very large, are found in the upper part of the group.

V. *The Scaphites Group* forms three beds; the lowest is composed of brown ferruginous sand, containing *Exogyra sinuata*, Sow., *Terebratula sella*, Sow., *Rhynchonella Gibbsiana*, Sow.; and of the Echinidæ I found *Cardiaster Benstedii*, Forb., and *Nucleolites Olfersii*, Ag.; the middle beds, about two feet in thickness, contain layers of nodules enclosing *Scaphites gigas*, Sow., and *Scaphites Hillsii*, Sow.; the upper consist of thick beds of greenish sand, containing, in the upper part, fine large specimens of *Exogyra sinuata*, Sow.

VI. *The Lower Crioceras Group* consists of ranges of large sandy nodules, enclosing *Crioceras Bowerbankii*, Sow.; the lowest range rises on the west of Whale Chine, and is succeeded by two other ranges, all three enclosed in sand about nine feet thick; the lowest, furnishing the best fossils, passes the bottom of Whale Chine, from whence I have obtained several large specimens.

VII. *The Walpen and Ladder Sands and Clay* extend from the east of Walpen to half way between Ladder and Whale Chines, where they are well seen; the lower half of this group contains *Ammonites Martini*, d'Orb., and a large *Gryphæa*; the upper half, which is clayey below and sandy above, contains *Dentalium*, *Myacites mandibula*, Sow., *Pinna Robinaldina*, d'Orb.

VIII. *The Upper Crioceras Group* consists of sandy nodules imbedded in sand, and contains *Crioceras Bowerbankii*, Sow., *Ammonites Martini*, d'Orb., *Gervillia solenoides*, DeFr., *Terebratula sella*, Sow., and several other shells. This group is seen for some distance along the shore east of Walpen Chine, which is crossed by it, as are also Ladder and Whale Chines.

IX. *The Walpen and Ladder Sands* consist of greenish and gray sand, with a layer of large fossiliferous nodules at the base, containing *Serpulæ*, *Thetis*, *Gervillia*, *Cucullæa*, *Corbula*, and other shells, together with an Urchin belonging to the genus *Brissus*.

X. *The Second Gryphæa or Exogyra Group*.—The lower part of this group consists of

sand and clay containing small nodules enclosing a *Brissus*, *Ammonites Martini*, d'Orb., and detached valves of *Exogyra sinuata*; above are three or four ranges of *Exogyra sinuata*, Sow.; the parallel edges of these large shells, as seen in the cliff, indicate three or four continuous strata, with irregular clusters between them. The second or upper Gryphæa group appears at low water at Shanklin, where the several ranges of *Exogyra* are seen rising beneath each other. Varieties of this shell appear to me to characterize different beds; for example, the specimens of *Exogyra* from the Crackers and Lower Gryphæa group present marked differences when compared with shells of the same species from the Upper Gryphæa group. A similar observation has been made by M. Cornuel on the *Exogyra* collected by him near Vassy, in France. This geologist assured Dr. Fitton "that he could at once assign each variety of form to a special place in the section of that vicinity." Small fragments of vegetable remains (*Lonchopteris Mantellii*, Brong.) occur not only in these beds, but nearly throughout the entire formation.

XI. *The Cliff-End Sands* consist of uniform sand about fourteen feet thick, with a subordinate bed of fossiliferous clay containing *Trigonia Dædalæa*, Park., in the lower part, and plant-like pyritiferous concretions in sand and clay in the upper part.

XII. *Foliated Clay and Sand*.—Consist of alternations of dark-blue clay and greenish, translucent, siliceous sand, containing nodules of pyrites and large irregular masses of coarse sandstone. These beds are well seen in Walpen and Black-Gang Chines, but no fossils have hitherto been found in them.

XIII. *Sands of Walpen and Black-Gang Undercliff*.—This group commences with a bed, about ten feet in thickness, of loose white sand, with thin laminæ of gray clay; this is succeeded by seventy feet of greenish and brownish sand overlain by seven feet of coarse ferruginous sand, with rounded grains of iron-ore in the lower half of the bed, and by twelve feet of alternating sand and clay, making a total of 100 feet. There are only very few fossils in this group—*Myacites plicata*, Sow., and *M. mandibulata*, Sow.

XIV. *The Ferruginous Bands of Black-Gang Chine* rise from the shore between Rocken End and Black-Gang Chine, and form the uppermost fossiliferous group of the Lower Greensand; they are composed of brown and yellow sand, with layers of ferruginous concretions, overlain by a bed of ferruginous sandstone, about five feet in thickness; the group is about twenty feet in all, and is the equivalent of the zone of Lower Greensand at Parham Park, and other places in Sussex, and near Sandgate in Kent. The sands in this group are fossiliferous throughout, and the species identical with those found in the Perna bed and Cracker rocks at the bottom of the section.

XV. *The Upper Clays and Sand Rock* consist of forty feet of dark clay with pyrites, separated by eighteen feet of white and green-coloured sand from a mass of clays and sands sixty feet thick. The bed 47 of this group is dug near Rocken End for the manufacture of glass; it contains no fossils.

XVI. *Various Sands and Clay* constitute the remainder of the section; they measure about 120 feet in thickness, and are overlain by the Gault.

The Lower Greensand represents the upper portion of the rocks known as the *Terrain Néocomien* of MM. Thurmann and d'Orbigny; *Terrain Jurassique supérieur* of M. Mathéron; *Couches adossées au Jura* of Von Buch; *Formation Waldienne et Néocomienne* of MM. Dufrénoy and Élie de Beaumont; *Calcaire à Spatangues, L'Argile ostréenne*, of M. Cornuel; *Argiles tégulines et grès vert* and "*Terrain Néocomien*" (Wealden) of M. Leymerie. The French geologists consider the Wealden clay and Hastings sand as the inferior, and the Lower Greensand the superior, portion of their *Néocomien*, whilst English geologists describe the Wealden and Lower Greensand as distinct formations.

THE GAULT.

In several coast-sections the Gault is seen separating the Lower from the Upper Greensand; this bed of dark clay is called "the blue slipper," from the tendency of the overlying strata to form landslips by gliding over its surface. The charming scenery of the Undercliff has been in a great measure produced by the foundering of the Upper Greensand and Cretaceous rocks over the Gault clay; the rain-water having saturated these porous beds, bursts forth in springs, which wet the surface of the clay, and occasions slips of the superincumbent strata. A rich fertile soil is thus formed upon a broad terrace of stiff clay, exposed to the south, and sheltered from the north by a high mural escarpment of Upper Greensand. Under these favourable physical conditions vegetation springs up in great luxuriance, on a natural terrace high above the sea, producing a coast-scene unequalled in beauty in the British Isles.

The Gault is about 100 feet in thickness, and in the Isle of Wight contains few fossils, as *Inoceramus sulcatus*, Sow., and *I. concentricus*, Sow.; near Folkstone and Charmouth it has yielded many beautiful shells in high preservation. I shall figure some rare *Echinidæ* from this bed at Folkstone.

The Red Chalk is a remarkable stratum, supposed to be the equivalent of the Gault; it is limited both in thickness and extent, for if we take, says the Rev. T. Wiltshire, one hundred feet as its maximum and four feet as its minimum thickness, and 100 miles as its extreme length, we shall not be far from the truth. It is said to be peculiar to the English Chalk. It is well exposed at Speeton, near Filey, on the Yorkshire coast, and at Hunstanton Cliff, near Lynn, Norfolk; in both localities it is a red calcareous rock, deeply coloured by

the peroxide of iron, and containing minute siliceous grains, and small pebbles of chalcidony, quartz, flint, &c. This rock from Hunstanton yielded by analysis carbonate of lime, with a little alumina, 82·3 ; peroxide of iron, 6·4 ; silica, 11·3 = ; 100.



Hunstanton Cliff,¹ of which the annexed woodcut gives an idea, consists of five different beds—1st, the uppermost, or white chalk, is forty feet thick ; 2nd, bright-red chalk, four feet ; 3rd, yellow sandy bed, ten feet ; 4th, a dark brown pebbly stratum, forty feet ; and 5th, a dark-coloured bed, almost black, twenty feet.

These divisions at Hunstanton, the Rev. T. Wiltshire states, do not run into each other, but are quite distinct ; the red chalk is as clearly separated from the white as though the one had been covered by a broad band of paint, and the same remark holds true of the others. When the sun shines upon the cliff, and lights up the bright white, bright red, the pale yellow, and the dark brown and black, and casts a shadow over the mass of gaily tinted materials at the base, a picture is produced not easy to be surpassed in beauty, and certainly not to be fully appreciated unless it is seen.

The Red Chalk is very fossiliferous, containing Ammonites, Belemnites, Brachiopoda, Echinidæ, and Corals.

In compliance with my request, my friend the Rev. T. Wiltshire, F.G.S. has kindly sent me the following note, embodying his latest observations on the Red Chalk at Speeton.²

“In answer to your inquiry respecting the natural section of the Red Chalk at the

¹ For ample details, see the Rev. Thos. Wiltshire, on the ‘Red Chalk of England.’

² To this gentleman’s kindness I am likewise indebted for the above woodcut, copied from a water-colour drawing in his collection.

most northern extremity of that bed in England, viz., in the neighbourhood of the little Yorkshire village of Speeton, I send you a few scanty notes. On my first visit to Speeton, some years since, I imagined, as I subsequently described in the second volume of the 'Geologist Magazine,' and in the 'Proceedings of the Geologists' Association' for 1859, that the Red Chalk in Yorkshire consists of a couple of bands of a highly coloured marl, of about thirty feet in thickness from top to bottom, and that its fossils are of such forms as to imply a close relationship with Gault species. This opinion I derived from seeing the section in a gully to the east of the village; but subsequent investigations made upon the shore under the cliff, at a mile or more from the ravine, showed me that my former observations were slightly incorrect, and that the Red Chalk, in that part of Yorkshire at least, contains two more additional coloured bands, and that its total thickness from top to bottom is not less than 100 feet, and that its upper portion belongs to the Lower Chalk series.

"The highest bed of Red Chalk at Speeton may be seen rising from the beach at a very gentle inclination, at about a mile and a half to the south-east of the gully. This bed, which is of varying thickness throughout its course, may be estimated as being on an average about five feet thick; it is of a pale pink colour, very hard, and presents a strongly marked appearance from the white chalk, above and below, with which it is in contact. The fossils found in it are *Rhynchonella Mantelliana*, *Gryphæa vesicularis*, *Discoidea cylindrica*, *Holaster subglobosus*, *Spines of Cidaris*, *Spines of Diadema* small vertebræ and teeth, together with a considerable number of *Terebratulinae graciles*. Above this bed, in the white chalk, are found *Holaster subglobosus* and *Ammonites peramplus*. The pink band just mentioned is followed by a greenish-yellow chalk, about forty feet thick, almost destitute of organic remains, except fragments of *Inocerami*, and marked by numerous thin layers of marl, not unlike those met with in the Lower Chalk of Sussex. The next bed in descending order is one of a light pink colour, about three feet in thickness, likewise destitute of fossils, with the exception of fragments of *Inocerami*. This is followed by another stratum of greenish-yellow chalk, about nine feet thick, containing small *Gryphææ*, and *Terebratulæ semiglobosæ*, and *Peltastes*, but, like the two preceding beds, generally unfossiliferous. The greenish-yellow chalk is succeeded by five feet of white and red chalk, in thin bands, very deficient in organic remains, and this rests upon a pale-red band, about seven feet thick. In the upper part of this last seven feet of red material are many *Vermiculariæ umbonatae*, and in its lower portion many small *Terebratulæ* and *Inocerami*. About ten feet of greenish-white chalk, somewhat hard, is the next bed, in which few fossils are to be noted except a *Terebratula* and a bone or two of a Star-fish. In all these strata enumerated there is a marked absence of *Belemnites*, but in the succeeding and last bed, one of a bright-red colour, and more than thirty feet thick, they become exceedingly abundant. This red band is the one from which most of the Red Chalk fossils from Speeton are derived; it is exceedingly fossiliferous. In its uppermost portion very large *Terebratulæ* may be obtained, and generally many of an ordinary size; at about twenty feet below its commencement, *Belemnites*, *Pentacrinæ*,

and spines of a *Cidaris* occur, which appear to be distinct from the *Cidaris* spines, ninety-four feet above, in the pink band. There are, moreover, no traces of *Holaster subglobosus* nor *Discoidea cylindrica* in this bright-red bed; and Ammonites cannot be seen, though so numerous in the Speeton Clay, upon which it rests. This red band gradually becomes nodular, and of a bluish cast, and gradually merges into the Speeton Clay.

“Inland the Yorkshire beds put on a somewhat different appearance, for on the escarpment of the Wolds, as at Great Givendale, the beds of Red Chalk abound in pebbles and in *Terebratulæ biplicatæ*, a feature that is absent at Speeton, though conspicuous at Hunstanton, in Norfolk.

“A careful inspection of the fossils derived from the Red Chalk series of Yorkshire and Norfolk shows that the two extremities of the bed are very distinct in character, and have not much in common, and that the southern stratum is a more littoral deposit than the northern.”

My friend John Leckenby, Esq., F.G.S., of Scarborough, having studied critically the fossils of the Speeton Clay, has kindly supplied the following note on that formation, from which it appears that until now the true relations of this deposit have not been clearly understood.

“The Speeton Clay of Yorkshire, besides many minor subdivisions, presents two important and well-marked sections; well-marked lithologically, still more so by their fossils. The line of separation midway, or nearly so in the series, is also distinct and clear, with no passage-beds indicating a transition from one set of conditions to another. Its entire thickness cannot be less than 400 feet, but in consequence of the denudation of the inclined edges of its beds it nowhere presents a continuous section of more than 150 feet.

“The lower division is characterized in its upper beds by Ammonites and Gastropods, which I at one time felt inclined to refer to the Oxfordian system, and many palæontologists yet contend that the thick coronated Ammonites which here abound belong to the Oxfordian group. Without, however, doing violence to our preconceptions of stratigraphical relations, we shall find that they approach much more nearly to Portlandian types, as figured by d’Orbigny; and *Am. Gravesianus* cannot be distinguished from a common, but unpublished form, in the Speeton Clay. In the lowest beds of this lower division are found *Am. triplicatus*, *Am. excavatus* (var. *alternatus*, Von Buch), with univalve and bivalve shells identical with species which I have obtained from the Kimmeridge Clay of Lincolnshire, in a railway-cutting near Brigg. The line of demarcation before referred to is characterized by a thickish band of pseudo-coprolites, and by many remains of Saurian animals; it would appear that here there has been a period of repose, during which the Saurian dwellers upon a shallow reef disported themselves, and that we have a well-marked division between the close of the Jurassic and the commencement of the Cretaceous period. A large and almost perfect example was lately procured and is now in the possession of Right Hon. Lord Londesborough, the lord of the manor of Speeton.

“The habit of referring the whole of the Speeton Clay of Yorkshire to the Cretaceous period, in deference to established authorities, has hitherto prevented a clear reading of

the evidence furnished by its fossils, and from the fact of so many of its Ammonites of the Oolitic type being found, not *in situ*, but in boulders, has led to the inference of the existence, at some remote period, in Filey Bay, of great beds of Oxford Clay similar in character to the Oxford Clay of the south of England.

“The Ammonites can, however, with much more propriety, be referred to Portlandian types, and the wasted beds which have furnished the boulders doubtless pertain to the same epoch.

“Above the line of Saurian remains alluded to, all the fossils belong to the Cretaceous type; and amongst the exact representations of a Neocomian fauna many others are found which in general features closely resemble them. Amongst the former, *Ammonites Deshayesii*, Leym., and *Vermicularia Sowerbii* may be mentioned, while *Crioceras Beanii*, Phil., cannot easily be distinguished, if at all, from *C. Cornuelianum*, d’Orb.

“If we seek for the equivalents of the Upper Greensand in the Speeton Clay, we must do so rather in the lower beds of Red Chalk which overlie that deposit than in the clay itself; and the frequent presence therein of *Inoceramus Coquandianus*, d’Orb., favours this view.

“The junction of the lowest beds of Speeton Clay with the Coralline Oolite cannot be traced along the coast, but may be seen at some distance inland, near the village of Grimston, one of the stations on the line of railway between Malton and Driffield.”

The Gault is the equivalent of the *Étage Albien* of d’Orbigny, and the *Gault* of the Germans.

THE UPPER GREENSAND.

This formation forms an important feature in the physical geology of the Isle of Wight; in Compton and Sandown Bays it is seen in its relative position to the Lower Greensand below and the Chalk above, and in the Undercliff it forms a bold, mural, light-coloured escarpment, with rugged lines of cherty beds, producing a fine effect above the rich foliage which clothes the undercliff. According to H. W. Bristow,¹ Esq., F.G.S., the Upper Greensand under St. Catherine’s Down is about 155 feet thick; the lower fifty-five feet consist of “bluish, sandy, micaceous beds, throwing out water at their junction with the Gault, and passing upwards into yellowish-gray sand, also micaceous, with sandstone and some chert, forty feet thick. Sandstone and chert imbedded in sand make up the greater part of the rest of the section, the middle portion of which is mostly blue chert based upon seven feet of sandstone, inclosing a bed of freestone four feet thick, whilst the uppermost fifteen or twenty feet consist of calcareous sandstone, forming a vertical face at the summit of the cliff.”

In the island the remains of Echinidæ are not abundant in these beds; the Upper Greensand, near Warminster and Devizes (Wilts); Blackdown (Devon); and near Charmouth (Dorset), and Cambridge, are the best localities for the fossil Echinodermata of this formation.

¹ “Memoirs of the Geological Survey,” the ‘Geology of the Isle of Wight,’ p. 24.

CHLORITIC MARL.

At the base of the Chalk, and dividing that formation from the Upper Greensand, is a remarkable fossiliferous bed, full of green specks of silicate of iron, and called, in consequence, Chloritic Marl, which at St. Catherine's Down measures five feet in thickness. This Marl is characterized by a suite of fossils, some of which, as *Scaphites æqualis*, Sow., here appear for the first time, and seem to be special to the bed; with these are found *Ammonites varians*, Sow., *Amm. splendens*, Sow.; several PROTOZOA belonging to the genera *Spongia*, *Siphonia*, and *Scyphia*; ECHINODERMATA, as *Ananchytes lævis*, Deluc; *Catopygus carinatus*, Goldf.; and *Discoidea subuculus*, Leske; together with several species of MOLLUSCA. The same stratum occurs near Chardstock, from whence I have obtained many fine specimens of *Pseudodiadema tumidum*, Forbes, *P. subnudum*, Ag., *Pedinopsis*, *Holcypus*, and several other species, most of which are common to this rock and the Upper Greensand, of which it probably forms the uppermost bed.

The Upper Greensand appears to correspond to the *Glaucouie crayeuse* of the French, the *Tourtia* of the Belgians, the *Grünsand* of the Germans, and the *Étage Cénomaniën* of d'Orbigny.

THE LOWER CHALK, AND CHALK-MARL.

The Chalk formation occupies a large area in the Isle of Wight, and in the southern and eastern parts of England. It consists of nearly pure carbonate of lime, and in many cases is almost entirely composed of microscopic shells, either fractured or entire. My friend H. C. Sorby, Esq., F.G.S., by preparing thin slices of chalk on slides of glass for microscopic examination, has shown that many beds of that rock consist of from 90 to 95 per cent. of the cases of *Foraminifera*, and of comminuted shells. The chief difference between the Upper or soft white Chalk, and the Lower or hard Chalk is caused by the filling up of the cavities of the shells by calcite or crystalline carbonate of lime, where it has probably been deposited by infiltrating water, which has carried away some of the lime in percolating through the higher beds. The Chalk formation is divided into Chalk-marl at the base, Lower or hard Chalk without flints, and soft or Upper Chalk with flints. In the Isle of Wight the whole formation is 1300 feet in thickness, whilst in England it varies from 600 to 900 feet.

The Lower Chalk near Dover is of a grayish colour, and much indurated in parts. It is very rich in *Echinidæ*, and contains several new species. Unfortunately, many of the finest specimens are impregnated with iron, and perish by the decomposition of the pyrites. At Lewes, in Sussex, it is a hard, close-grained rock, with an earthy fracture, and contains many urchins in fine preservation.

The following section, by the Rev. W. D. Conybeare, of the Chalk cliffs near Dover,

exhibits so well the position and relation of the Gray Chalk, which contains so many fine Echinidæ, that I have introduced it here for reference. The strata lie in the following descending order, and are collectively about 820 feet thick.

1st. *The Chalk with numerous flints*; it is about 350 feet thick, and may be thus divided:

I. With few organic remains.

II. A bed consisting chiefly of organic remains in which numerous flints of peculiar forms are interspersed; and a few beds of flints run along it.

2nd. *The Chalk with few flints*. This stratum is about 130 feet thick.

3rd. *The Chalk without flints* is 140 feet thick, and consists of—

I. A stratum containing very numerous and thin beds of organic remains, 90 feet thick.

II. A stratum about 50 feet thick, with few organic remains.

4th. *The Gray Chalk*. This is estimated to be not less than 200 feet in thickness, and is that from which has been collected most of the fine specimens of *Cidaris Bowerbankii*, Forb.; *Pseudodiadema ornatum*, Forb.; *P. tumidum*, Forb.; *P. variolare*, Brong.; *P. Brongniarti*, Ag.; *P. Mackiei*, Wowd., *Salenia Austeni*, Forb.; *S. Clarkii*, Forb.; *S. gibba*, Forb.; *S. granulosa*, Forb.; and *S. petalifera*, DeFr., with other specimens of Chalk-marl species.

The Lower Chalk and Chalk-marl are represented on the Continent by the *Untere Kreide* and *Pläner* of the Germans, the *Craie tuffeau* of the French; and the *Étage Turonien* of d'Orbigny.

THE WHITE CHALK.

The uppermost portion of the Cretaceous formation extends across the island in an east and west direction, from the Needles to Culver Cliff, and all its beds are fully exposed in several magnificent coast-sections; as these beds are nearly vertical or highly inclined at Alum and Scratchells Bays on the east, and at Culver Cliffs on the west, the subdivisions of the whole Cretaceous formation, and the way the beds pass into each other, may be most satisfactorily ascertained. The bands of flints are well displayed in Scratchells Bay and Culver Cliffs, and there is a fine exposure of vertical Chalk strata in a pit on Brading Down; in all these localities, and many others which it is unnecessary to enumerate, the flints appear as parallel layers at certain intervals in the strata, presenting a striking contrast from their blackness to the snowy aspect of the Chalk with which they are interstratified.

“In consequence of the high angle at which the Chalk dips throughout the greater

part of its range from west to east, the surface occupied by it is very inconsiderable compared with that of most of the other strata above and below it, but its horizontal extension becomes greater in proportion as the inclination of the strata diminishes. For this reason, from Alum Bay to Mottestone Down, and from Carisbrook to Culver Cliff, between which intervals the Chalk is nearly vertical, it constitutes a mere ridge of high land, which is scarcely a quarter of a mile broad in Aston Down; but between Mottestone Down and Carisbrook, where the strata are less inclined, the width of the Chalk exceeds three miles.”¹

“The flints in the Chalk are for the most part irregular in shape, but they sometimes constitute tabular layers coincident with the stratification, or else filling cracks and joints. Those flints which occur parallel with the bedding are of a different age from those filling the cracks and joints. The former are derived from siliceous matter, frequently, and perhaps in most instances, deposited contemporaneously with the calcareous sediment of which the Chalk is composed, around sponges and other organized bodies, the forms and internal structure of which are still preserved. The latter, on the contrary, are of more recent origin, having been carried by percolating water holding silica in solution into cracks and joints formed by the Chalk during or after its solidification. The tabular bands of flint filling cracks and joints are therefore, and as might be expected on the last supposition, unfossiliferous, instead of abounding in fossils, as is the case with the other system of flints.” “In the upper part of the Chalk, where the beds are the most highly inclined, the flints, which appear to be whole when viewed *in situ*, are found, on closer examination, to be nearly all broken so that when extracted from the quarry they fall to pieces.” “Shattered flints may be observed in the large chalk-pits south of Newport, and on Arreton Down; also on Ashley Down, where the Chalk is rather hard (as is most frequently the case where it is inclined at a high angle), dipping 65° in a direction slightly east of north.”²

The White Chalk contains many species of Echinidæ, of which the most common are *Echinocorys vulgaris*, Breyn.; *Galerites albo-galerus*, Lamck.; *Micraster cor-anguinum*, Klein; *Cidaris clavigera*, König; *Cidaris sceptrifera*, Mant.; *Cidaris subvesiculosa*, d’Orbigny, and several other forms, to be figured and described in the following pages.

The “Upper White Chalk with flints” of English authors corresponds to the *Craie blanche* of the French, the *Obere Kreide* of the Germans, and the *Étage Sénonien* of d’Orbigny.

Besides the localities already mentioned, it is well exposed and very fossiliferous at Lewisham, Grays, Northfleet, Norwich, Brighton, Dover, and other places in the counties Sussex and Kent, and at Flamborough Head, on the Yorkshire coast.

The following table exhibits at a glance the subdivisions of the Cretaceous formations, with their lithological characters, chief localities, and foreign equivalents, so as to afford an easy reference to the stratigraphical distribution of the species of Echinidæ in each of the beds.

¹ Bristow, on the “Geology of the Isle of Wight,” ‘Mem. of the Geol. Surv.’ p. 28.

² Bristow, *ibid.*, p. 31.

A TABLE OF THE CRETACEOUS GROUP OF ENGLAND.

	SUBDIVISIONS.	LITHOLOGICAL CHARACTER.	LOCALITIES.	FOREIGN EQUIVALENTS.
THE CRETACEOUS GROUP.	UPPER CHALK	Nearly pure carbonate of lime, with minute fragments of Shells and Foraminifera, forming a white or yellowish-white, soft Chalk; the upper beds of which are interstratified with layers of flints, or tabular layers of dark silex coincident with the stratification.	Isle of Wight, Lewisham, Grays, Northfleet, Norwich, Brighton, Dover, Flamborough Head.	<i>Craie blanche</i> , French. <i>Obere Kreide</i> , Germans. <i>Étage Sénonien</i> , d'Orb.
	LOWER CHALK, and CHALK-MARL.	Hard Chalk, without flints, sometimes passing into Chalk-marl or hard Gray Chalk.	Dover, Folkestone, Lewes (Sussex), Swaffham, Norwich.	<i>Untere Kreide</i> , Germans. <i>Pläner</i> , Germans. <i>Craie tuffeau</i> , French. <i>Étage Turonien</i> , d'Orb.
	CHLORITIC MARL ...	Light-coloured marl, full of green specks of silicate of iron, with numerous fossils.	Chard, Chardstock, St. Catherine's Down, Isle of Wight.	<i>Glauconie crayeuse</i> , French. <i>Tourtia</i> , Belgians.
	UPPER GREENSAND .	Siliceous sand, or nearly calcareous sand, with green grains; the rock often contains nodules of chert and masses of limestone.	Warminster, Devizes, Chute Farm, Petersfield, Cambridge, Charnmouth, Dorset.	<i>Grünsand</i> , Germans. <i>Étage Cénomanien</i> , d'Orb.
	GAULT	Dark-blue tenacious clay, sometimes marly, with some concretions.	Isle of Wight, Folkestone, Charnmouth.	<i>Gault</i> , Germans.
	RED CHALK	A thin bed of hard, red Chalk, deeply coloured by the peroxide of iron, and having numerous small siliceous grains and pebbles of quartz, &c., strewed throughout the mass.	Hunstanton Cliff, Norfolk; Filey Bay, Yorkshire.	<i>Étage Albien</i> , d'Orb.
	SPEETON CLAY. } [Upper part.] }	A grayish-coloured clay, the upper portion containing Neocomian, the lower portion Portlandian species of fossil shells.	Filey Bay, Yorkshire.	
	LOWER GREENSAND .	A great arenaceous formation, composed of ferruginous sands with green grains, dark-coloured clays and clayey sands; and in some localities, bands of limestone known as Kentish Rag.	Isle of White, Folkestone, Hythe, Maidstone.	<i>Terrain Néocomien supérieur</i> of Swiss and French. <i>Étage Aptien</i> , d'Orb.

CLASSIFICATION OF THE ECHINODERMATA.

The name ECHINODERMATA was given by Klein, in 1734,¹ to the shells of Sea-urchins called Echini. Bruguière² subsequently gave the name Echinodermata to that division of the animal kingdom which comprised the Star-fishes and the Sea-urchins. Cuvier³ included in his class ÉCHINODERMES, with *Asterias* and *Echinus*, the *Holothuria*, animals destitute of the prickly skin of the more typical forms, and which had many external affinities with some Mollusca; and subsequently, in his 'Règne Animal,'⁴ he grouped in this class *les Échinodermes sans pieds*, forming the order Sipunculida, which connect the Radiata with the Annulose Articulata.

The Echinoderms are highly organized animals, for the most part covered with a coriaceous integument. In several orders it is strengthened with numerous calcareous pieces, which together form a complicated skeleton. The external surface of the skin, in many families, develops spines of various forms, which serve as instruments of defence or locomotion to the creatures possessing them. By far the largest number of these animals have a complicated system of vessels for circulating water through their bodies. These aquiferous canals are intimately connected with the life and motion of the animal; by means of this vascular water-system most of the typical groups erect those remarkable suckers which protrude in rows from different divisions of the body; in the *Echinoidea* they escape through holes in the poriferous zones, and in the *Asteroidea* pass through apertures between the small plates forming the middle of the rays; whilst in the *Sipunculida* these organs are altogether absent.

No class of the animal kingdom more clearly exhibits a gradation of structure than the *Echinodermata*; for, whilst some remain rooted to the sea-bottom, and in this sessile condition resemble the *Polypifera*, others, clothed in prickly armour, and exhibiting the true rayed forms characteristic of the central groups, conduct, through a series of beautiful gradations, to soft elongated organisms, whose outline mimics the *Ascidian Mollusca*, whilst others exhibit the long cylindrical body, annulose condition of the skin, and reptatory habits of the *Apodous Annelida*.

With so fertile a field for investigation, it is not surprising that the minute anatomy of the Echinodermata should have engaged the attention of some of the most distinguished zoologists of our age, and have yielded fruits which the physiologist reckons as amongst the most marvellous contributions to morphological science.

¹ 'Naturalis Dispositio Echinodermatum,' Jacobi Theodori Klein, 1734.

² 'Tableau Encyclopédique des trois Règnes de la Nature,' 1791.

³ 'Tableau Élémentaire de l'Histoire naturelle des Animaux,' 1798.

⁴ 'Règne Animal destribue d'après son Organisation,' 1834.

The class Echinodermata is divided into eight orders, which, in descending sequence, may be thus arranged :

1. SIPUNCULOIDEA.		5. OPHIUROIDEA.
2. HOLOTHUROIDEA.		6. BLASTOIDEA.
3. ECHINOIDEA.		7. CYSTOIDEA.
4. ASTEROIDEA.		8. CRINOIDEA.

Order I. SIPUNCULOIDEA.—form the apodal Annulose Echinoderms; they have a long cylindrical body, divided into rings by transverse folds of the integument; they have neither tubular suckers nor calcareous parts developed in their body, nor is it divided into a quinary arrangement of longitudinal lobes; some have horny hooklets like the feet of many Annulosa, which they much resemble; their mouth is provided with a retractile proboscis, and surrounded by small tentacula, differing both in structure and arrangement to the homologous parts in the *Holothuria*. In them the type of *Radiata* vanishes and that of *Annulosa* appears. They are unknown in a fossil state.

Type. *Sipunculus edulis*, Pallas.

Order II. HOLOTHUROIDEA.—Body in general elongated; skin in general soft and leathery, in a few genera strengthened by calcareous or horny spines. Five avenues of suckers divide the body into as many nearly equal segments; mouth surrounded by plumose tentacula, the numbers of which are usually multiples of five; vent at the opposite extremity of the body; digestive organs consist of a large intestine, which makes several coils in passing through the body; respiration performed by internal ramified tubes, like a miniature tree; locomotion effected by contractions and extensions of the body, and by rows of tubular suckers, similar to those in the Star-fishes and Sea-urchins. The softness of their naked integument prevents their preservation in the stratified rocks.

Type. *Cucumaria frondosa*, Gunner.

Order III. ECHINOIDEA.—Body spheroidal, oval, or depressed, enclosed in a test, composed of twenty columns of calcareous plates, with ten rows of holes for the passage of retractile tubular suckers; the surface of the test is studded with tubercles, which have jointed with them moveable spines, of various sizes and forms in the different families and genera; at the summit of the test is the apical disc, composed of five genital plates, perforated for the passage of the ovarian and seminal tubes, and five ocular plates for lodging the five eyes. The mouth, situated always at the under surface, is in many genera armed with five powerful, complicated jaws and teeth, and in others the peristome is edentulous; the vent occupies various different positions, sometimes within the apical disc and surrounded by its elementary parts, sometimes external to the disc, and at the upper surface, side, or base, the relative position of the vent to the disc affording

an important character for the subdivision of the order into two primary groups. The intestine winds round the shell, attached by a mesentery, the surface of which, as well as the membrane lining the shell, is covered with vibratile cilia.

Type. The common Sea-urchin, *Echinus sphaera*, Müller.

The ECHINOIDEA are represented by one family in the Palæozoic rocks, and by numerous families in the Mesozoic and Tertiary groups, several of which characterize these great periods of geological time. They likewise abound in our present seas.

Order IV. ASTEROIDEA.—Body stelliform, depressed, with five or more lobes or hollow arms, forming a continuation thereof, and containing prolongations of the viscera; the mouth is always inferior and central, and the intestine often terminates in a vent opening at the upper surface; in some genera the vent is absent; rows of retractile tubular suckers occupy the ambulacral areas in the centre of the under surface of the rays. Skeleton complicated, composed of numerous solid calcareous pieces, variable as to number, size, and disposition; skin coriaceous, studded with calcareous spines of various forms; a madreporiform plate on the upper surface, near the angle between two rays; eyes placed at the extremity of the rays; reptation performed by tubular suckers.

Type. The common Star-fish, *Uraster rubens*, Linn.

This order is represented in the Silurian rocks by several genera. The Oolitic, Cretaceous, and Tertiary rocks contain many extinct forms. The existing species are very abundant in all our present seas.

Order V. OPHIUROIDEA.—Body discoidal, distinct, depressed, provided with long, slender arms, in which there is no excavation nor prolongation of the viscera; they are special organs of locomotion, independent of the visceral cavity, and have spines, and membranous tentacula developed from their sides; mouth always below and central, serving at the same time as the vent. Skeleton complicated, composed of calcareous pieces, of which the size and number varies in different genera. Their long, slender rays are supported internally on a framework of central vertebra-like pieces; they form special organs of locomotion, independent of the visceral cavity, and numerous plates and spines are regularly disposed along their sides to assist in reptation.

Type. The common Sand-star, *Ophiura texturata*, Lamarck.

This order is represented by one genus in the Silurian, and several genera are found in the Oolitic, Cretaceous, and Tertiary rocks, as well as in our present seas.

Order VI. BLASTOIDEA.—Body in the form of an oval calyx, composed of solid, calcareous plates, provided with five inter-ambulacra and five ambulacra, the latter united superiorly, striated transversely, and having a deep furrow down the middle; ten ovarial holes, opening into five at the summit, with a central oral aperture, a short, slender stem, and the body destitute of arms.

Type. *Pentremites inflatus*, Sow. Carboniferous Limestone.

The genera are all extinct, and belong to the Palæozoic rocks. One species appertains to the Upper Silurian, six to the Devonian, and twenty-four are special to the Carboniferous rocks.

Order VII. CYSTOIDEA.—Body more or less spherical, supported on a jointed stem; the bursiform calyx is formed of close-fitting polygonal plates, varying in number in the different genera, and investing the surface like a coat of mail, except above, where there are three openings, one for the mouth, one for the vent, and one with a valve for the reproductive organs; the fourth aperture is below, and continuous with the canal in the stem. Some have two or four arms, others are armless; certain forms possess articulated tentacula and curious comb-like appendages, or pectinated rhombs, in connection with the plates.

Type. *Pseudocrinites quadrifasciatus*, Pearce. Upper Silurian.

This order is extinct. All the genera are found in the Silurian and Devonian rocks.

Order VIII. CRINOIDEA.—Body fusiform, distinct, formed of a calyx composed of a definite number of plates, provided with five solid arms, independent of the visceral cavity, and adapted for prehension; mouth and vent distinct; no retractile suckers; ovaries at the base of the arms opening into special apertures. Skeleton complicated, calcareous, composed of thick plates closely articulated together; their number and arrangement are determinate in the different families, the multiples of five being those which predominate; the central plate of the body is supported on a long, jointed column, that was firmly rooted to the sea-bottom. The mouth is central, and prominent; the vent is situated at its side; the arms are mostly ramose and multi-articulate, and when extended formed a net-like instrument of considerable dimensions. The mouth is always placed upwards, and retained so by the column being jointed to the central plate of the calyx. The normal station of the CRINOIDEA is the reverse of the ASTEROIDEA and ECHINOIDEA.

Type. *Pentacrinus Caput-Medusæ*, Miller. From the seas of the Antilles.

Extinct families of Crinoids have lived in all seas from the Silurian upwards, and only one or two representatives now exist.

From the above analysis of the class ECHINODERMATA, it appears that, as the *Sipunculoidea* and *Holothuroidea* are not found in a fossil state, and the *Blastoidea* and *Cystoidea* are special to the Palæozoic rocks, our field of investigation in this Monograph is limited to the ECHINOIDEA, ASTEROIDEA, OPHIUROIDEA, and CRINOIDEA, which we now propose to consider seriatim, commencing with the ECHINOIDEA.

Order—ECHINOIDEA.

The body is spheroidal, oval, depressed or discoidal, and enclosed in a calcareous test or shell, composed of ten columns of large plates, *the inter-ambulacral areas*, and ten columns of small plates, *the ambulacral areas*, separated from each other by ten rows of holes, *the poriferous zones*. The external surface of the plates is studded with tubercles of various sizes, in the different families; to these the spines are moveably articulated by ball-and-socket joints; the spines are of various forms and dimensions, and serve well to characterize the species.

At the summit of the test is the apical disc, composed of five genital plates, perforated for the passage of the ovarian and seminal canals, and five ocular plates, notched or perforated for lodging the eyes. There are two great openings in the test, one for the mouth and the other for the vent; the relative position of these apertures varies in different families, and forms an important character in their systematic classification.

The mouth in some families is armed with a complicated apparatus of jaws and teeth, in others it is edentulous. The internal organs of digestion consist of a pharynx, œsophagus, stomach, and intestine, which winds round the interior of the test, attached thereto by a delicate mesentery; its surface, as well as the lining membrane of the shell, is covered with vibratile cilia; these cause currents of water to traverse the interior of the body, and perform an important part in the function of respiration; the blood is circulated in arteries and veins, aided by a central pulsating organ or heart. The five ovaries and testicles occupy the ambulacral divisions, and open externally through holes in the genital plates. Locomotion is performed by the joint action of the tubular retractile suckers and the spines. Many sea-urchins attach themselves to rocks by their tubular feet, and some bury themselves in limestone and sandstone, or even granitic rocks, by the abrading action of the spines.

The nervous system consists, according to M. Van Beneden, of a circular cord, which surrounds the entrance to the digestive organs, and sends branches into the divisions of the body. Professor Agassiz, and the late Professor Edward Forbes, regarded the organs situated in the ocular plates as eyes, but M. Dujardin¹ denies them even a nervous system. In the absence of more direct anatomical evidence on the point, the following observation, related by M. Alcide d'Orbigny,² has an important bearing on the question, and supports it affirmatively:

Captain Ferdinand de Candé, who commanded the 'Cléopâtre' in the Chinese seas, told M. d'Orbigny that he had captured, on the coast of that region, an urchin with long spines, probably a *Diadema*, which he examined in a vessel of water, "I hastened to

¹ Lamarck, 'Animaux sans Vertèbres,' 2nd ed., tom. iii, p. 200.

² 'Paléontologie Française, Terrain Crétacé,' tom. vi, p. 12.

seize it," he observed, "when it instantly turned all its spines in the direction of my hand, as if to defend itself.

"Surprised at this manœuvre, I made an attempt to seize it on the other side, when immediately the spines were directed towards me.

"I thought from this that the urchin saw me, and that the motion of the spines was intended as an act of self-defence; but, to prove whether the movement of the animal was produced by my approach, or merely by the agitation of the water, I repeated the experiment very slowly, and even over the water with a stick. The urchin, whether in the water or out of it, having always directed its defensive spines towards the object which approached it. From these observations I arrived at the conclusion that these urchins see, and that their spines serve them as defensive instruments."

It is worthy of remark, that Captain Candé, at the time he watched this urchin, was ignorant of the anatomical fact that eyes had been detected in the Echinidæ, and his inference was the conclusion drawn from carefully made observations.

The calcareous test of the Echinoidea is the only part of the structure of these animals preserved in a fossil state. It has hitherto failed to attract that amount of attention from the palæontologist which the importance of its study demands; although in a stratigraphical point of view this skeleton is not inferior to that of any other class of the Animal Kingdom. The fact seems to have been almost entirely overlooked by palæontologists, that most of the generic characters of the different groups of Echinidæ are more indelibly impressed on the separate pieces of their test than in the skeletons of any other class of the Invertebrata.

Unlike the shells of the Mollusca, the test of the Echinoidea constitutes an internal and integral portion of the animal, being secreted by, and enclosed within, organized membranes, it participates in the life of the organism, and certain parts of the skeleton are intimately connected with the organs of digestion, respiration, and generation, as well as with those of vision and locomotion.

As it is intended to give an analysis of the test of the Echinoidea, with anatomical details of the structure of the skeleton in the Echinodermata in general, in the General Introduction to these Monographs, it is at present unnecessary to enter minutely into the subject; but, as many of our readers are doubtless unacquainted with the terminology employed in the description of the test, and the characters on which a diagnosis of the species is made, it is desirable now to preface our description with brief explanations of the same, illustrating the terminology by a reference to the plates for accurate figures of different parts of the test, and magnified details of the anatomical characters thereof.¹

¹ In connection with the physiology of the Echinodermata, the following discovery, made by Dr. Wallich, is most important:

"Thirteen living star-fishes, differing in no important particular from a species common on our own and most northern coasts, were brought up from a depth of 1260 fathoms, or very nearly a mile and a half, at a point midway between the southern extremity of Greenland and Rockall, and 250 miles distant from the nearest land. These star-fishes, however, cannot be said to have been captured by the sounding-

TERMINOLOGY,

Or a descriptive analysis of the component elements of the test of the Echinoidea.

The test of the Echinoidea is composed of the following parts :

- a.* Five ambulacral areas.
- b.* Five inter-ambulacral areas.
- c.* Ten poriferous zones.
- d.* Vent-opening and anal plates.
- e.* Mouth-opening, peristome, buccal membrane and plates.
- f.* Five jaws when organs of mastication exist.
- g.* Tubercles of various sizes, developed from the outer surface of the plates.
- h.* Spines of different forms and dimensions, jointed with the tubercles.

These are the essential parts to be known ; others, of secondary importance, will be described in their proper place in the Monograph.

The body of the Echinoidea is divisible into three parts :—1st. The calcareous envelope, or skeleton, which has a globular, circular, oval, pentagonal, hemispherical, conoidal, or discoidal form, and is composed of a framework of hexagonal, pentagonal, or polygonal calcareous plates. This testaceous box is called the test ; it is the *form*, the *test*, of Agassiz ; the *general form*, the *test*, of Desmoulins ; *le coquille*, d'Orbigny.

machine, for they came up adhering by their spine-covered arms to the last fifty fathoms of the sounding-line, not as voluntary exiles from below, but owing to their having coiled themselves around a material from which they found it impossible afterwards to disengage themselves. Now, apart from all other evidence, the facts in connection with this particular sounding were sufficient to indicate that the star-fishes had been raised from the sea-bed itself, and had not grasped the line whilst floating in some stratum of water intermediate between it and the surface. But, by a singular piece of good fortune, the question as to their last resting-place admitted of definite determination on evidence that they bore along with them. To comprehend the value of this, it is necessary to mention that, by means of a separate observation taken upon the same spot, the bottom was found to consist almost entirely of the minute shell-covered organisms (Foraminifera) already referred to ; and taking into consideration the fact that many of the shells were completely filled with the gelatinous substance of which their bodies are composed, and, lastly, the fresh appearance of this substance, the probability is very great that they, in common with the star-fishes, had lived and multiplied at the bottom. But the only circumstance which ought to be accepted as direct proof of their vitality, namely, motion after reaching the surface, was wanting ; as it well might be, since the passage through the vertical mile and a half of water occupied nearly an hour, and the change of conditions to which the creatures became subjected during that period must necessarily have been very great. Nevertheless, the chain of circumstantial evidence was rendered complete ; for, on examining the stomachs of the star-fishes, they were found to contain the minute shelled creatures in abundance, thus clearly establishing the fact of the star-fishes having attached themselves to the sounding-line whilst it rested on the bottom, and adding the strongest confirmation to the view that the minute creatures referred to were brought up from their natural habitation." (Dr. Wallich, "On the Deep-Sea-Bed of the Atlantic, and its Inhabitants ;" 'Quarterly Journal of Science,' No. 1, p. 40.)

2nd. The visceral cavity, containing the organs of digestion, respiration, circulation, and generation, is formed entirely by the interior of the test.

3rd. The external surface of the test is covered with spines, which are moveably articulated, with the tubercles seen on the surface.

The normal position of the body.—In describing the different parts of the test of the Echinoidea, it is assumed that an urchin, the common purple heart-urchin, *Spatangus purpureus*, Müller,¹ for example, is placed before the observer. The side with the single ambulacrum lodged in the anteal sulcus, and the mouth in that third of the base, is the *anterior region*. The side having the single inter-ambulacrum in the middle and the vent-opening in the upper part of the border is the *posterior region*. The four other ambulacra are disposed in pairs, and correspond to the right and left sides of the observer's body; there is, therefore, a right antero-lateral and a right postero-lateral, a left antero-lateral and left postero-lateral, ambulacral area. The four other inter-ambulacra, besides the single one in which the vent is situated, are likewise disposed in pairs, two of these, with the single ambulacrum, forming the anterior part, the other pair, with the pairs of ambulacra, the sides, and the single inter-ambulacrum the posterior part of the test.

All Echinoideæ have the mouth situated at the under side of the body; the surface in which the opening is placed is *the base*, that region of the test opposite the base is the *upper* or *dorsal surface*.

The most convex part of the margin, border, or sides, between the base and upper surface, is the *circumference*, or *ambitus* of some authors; it is round, flat, convex, angular, or carinated, according to the general form and thickness of the test.

The *length* or *antero-posterior* diameter is the distance between the anterior and posterior regions, and corresponds to the middle line of the body.

The *breadth* or *transverse* diameter is the distance between the greatest lateral convexity of the circumference in the direction of a line cutting the line of length at right angles.

The *height* is the distance between the most convex part of the upper surface and the plane on which the base of the test rests. The apical disc is generally situated at the vertex, but it is not always so; the height has always reference to the highest point of the test, quite irrespective of any other consideration. The test has invariably two openings, one for the mouth, the other for the vent.

The mouth-opening is always situated at the under surface; to its circumference is attached the buccal membrane, and through the central aperture thereof protrudes the five jaws (Pl. V, fig. 1; Pl. VII, fig. 1); when they exist, the buccal, like the anal membrane in many families, is clothed with numerous small plates.

In the *Cidaris*, *Rabdocidaris*, *Goniocidaris*, *Diplocidaris*, and probably in all other

¹ The common Chalk-urchin *Miraster cor-anginum*, Klein, will answer equally well.

Cidaridæ, the mouth-opening is central, circular, or slightly pentagonal (Pl. IV, fig. 16); but in *Hemicidaris*, *Pseudodiadema*, *Hemipedina*, *Pedina*, *Echinus*, and other *Echinidæ*, the mouth-opening is more or less decagonal, its margin being divided by notches (*entailles*) into ten lobes; the lobes, in general, are unequal in size, those corresponding to the base of the ambulacra being the largest; they are called the *ambulacral lobes*; corresponding to the base of the inter-ambulacra are the *inter-ambulacral lobes*. The margin of the mouth-opening is called the *peristome*, to it the buccal membrane which closes the base of the test is attached.

The *mouth-opening* is central and armed with jaws in the CIDARIDÆ, ECHINIDÆ, SALENIDÆ, GALERITIDÆ, and CLYPEASTERIDÆ. It is more or less excentral and edentulous in the ECHINONIDÆ, COLLYRITIDÆ, ECHINOLAMPIDÆ, ECHINOCORYDÆ, and SPATANGIDÆ; in them it is round, oval, or pentagonal; sometimes its margin is ring-like, or surrounded by five prominent lobes; in others it is distinctly bilabiate.

The *vent*, or *anal opening*, is always in the upper surface, in the centre of the genital and ocular plates, directly opposite to the mouth, and is either central or subcentral in the CIDARIDÆ, ECHINIDÆ, and SALENIDÆ (Pl. VI, fig. 1). In other families its position varies much; sometimes it opens on the upper surface, as in some GALERITIDÆ and CASSIDULIDÆ. Sometimes it opens on the margin or is *supra-marginal*, marginal or *infra-marginal*; often it opens at the base between the mouth and the border. During the life of the animal this opening is closed by an anal membrane and a series of small angular anal plates; their number and disposition varies in the different genera. The anal plates are seldom preserved in fossil species, and the term anal opening is given to all that part of the test occupied by them and the vent. Pl. VI, fig. 1 *a*, is a magnificent specimen of *Cidaris sceptrifera*, Mant., belonging to the British Museum, in which the anal plates are finely preserved *in situ*.

The Ambulacral and Inter-ambulacral Areas.

The test is composed, 1st, of twenty columns of calcareous plates of different sizes, the *plaquettes*, *Täfelchen*, *Assulæ* of authors; they are pentagonal in form, and united by harmonial sutures to form rays, which proceed from the mouth, where they have their greatest breadth, to the apical disc, where they are narrowest. 2nd. Of a series of hexagonal or polygonal plates, forming a disc, which occupies the upper surface of the test. 3rd. Of ten rows of small plates, notched on their margins to form holes; these form the poriferous zones. 4th. Of moveable spines, that are jointed with eminences on the outer surface of the columnar plates.

The *ambulacral plates* form two narrow columns, which are bounded by two poriferous zones. The space thus circumscribed is the *ambulacral area*. There are five of these areas in the test of the Echinoidea. In the CIDARIDÆ the ambulacral areas are very narrow, and support only granules (Pl. VI, fig. 1, *a*, *b*, *c*, *d*). In the ECHINIDÆ, they are much

wider, and have large tubercles on their surface. The comparative width of the ambulacra as compared with the inter-ambulacra has led some authors¹ to divide the family *Cidaridæ*, including therein the *Echinidæ*, into two tribes, the *ANGUSTISTELLÆ*, or *Cidaridæ* with narrow ambulacra, and the *LATISTELLÆ*, or *Cidaridæ* with broad ambulacra. These two tribes nearly represent our two families; the *CIDARIDÆ* are equal to the *ANGUSTISTELLÆ*, and the *ECHINIDÆ* are nearly equal to the *LATISTELLÆ*.

One of the ambulacral areas is single, and always represents the anterior region in the spheroidal *Echinidæ* and *Salenidæ*. This is detected by its relation to the apical disc, as the right antero-lateral plate always carries the madreporiform body; in the oval, pentagonal, or elongated forms, its position and relation to the mouth renders it unmistakable. The four other ambulacra are disposed in pairs.

The *inter-ambulacral plates* form two broad columns, composing the inter-ambulacral areas; of these, like the ambulacral, there are five, which alternate with them in the architecture of the test. The poriferous zones form the line of demarcation between these two classes of columnar plates. The plates are all pentagonal, and many times larger than the ambulacral; they carry on their surface the large primary tubercles. Of the five inter-ambulacral areas, one is single and posterior, and in all the Echinoideæ which have the anal opening external to the apical disc it is in the single inter-ambulacrum that the vent terminates. The other four inter-ambulacra are disposed in pairs, and form the greater part of the anterior and lateral parts of the test; they are the *anterior pairs* and *posterior pairs*, respectively, to distinguish them from the odd area, which is the *single inter-ambulacrum*.

Pl. VI, fig. 1, shows the form and structure of the inter-ambulacra in the *Cidaridæ*.

In the *Cidaridæ* the inter-ambulacral areas have only two rows of primary tubercles; but in many of the *Echinidæ* there are four, six, eight, or ten rows of primary tubercles in these areas.

The Poriferous Zones.

The *poriferous zones* are situated on each side of the ambulacral areas (Pl. VI, fig. 1); they are composed of a very great number of small pieces, articulated together in such a manner as to form a series of holes. The corresponding edges of the plates remaining uncalcified, at certain definite intervals produce foramina, which are destined for the passage of retractile tubular suckers. The form and structure of the poriferous zones form a good generic character. As there are two poriferous zones bordering each ambulacral area, it follows that there are ten zones. Some authors give the collective name *ambulacra* to the *zones* and the *area*; but for obvious reasons, I consider them distinct sections of the test, and treat them as such.

¹ Albin Gras, 'Description des Oursins Fossiles du département de l'Isère,' p. 20. E. Désor, 'Synopsis des Échinides Fossiles,' p. 26.

The pores are *round*, *oblong*, or *elongated*; the pores forming a pair may be *equal* or *unequal*; in relation to each other, they may be *transverse* or *oblique*, *contiguous* or *remote*, and when united by a transverse sulcus they are said to be *conjugate*.

The pores are differently arranged in the zones in the different families: when they are disposed in single pairs, they are said to be *unigeminal* (Pl. VI, fig. 1, *d*); when in double pairs, *bigeminal*; when in triple oblique pairs, *trigeminal*; and when grouped in a greater number, as in many living species of the genus *Echinus*, they are *polygeminal*.

When the zones extend in a straight uninterrupted line from the mouth to the apical disc, they are said to be *simple*, as in the *Cidaridæ*, *Echinidæ*, *Salenidæ*, *Galeritidæ*, *Echinonidæ*; when the zones, after parting from the apical disc, expand, and again contract, thereby forming a leaf-like figure on the upper surface of the test, they are said to be *petaloidal*, as in the *Clypeasteridæ*; when the petal is not so complete, as in the *Cassidulidæ*, it is *subpetaloidal*. The zones are *complete* when they extend without interruption from the mouth to the disc; they are *interrupted* when they terminate on the upper surface, and reappear again at the base near the mouth; they are *limited* when they form only a star on the dorsal surface. These terms represent generic characters of greater or less value, and require to be carefully noted in the description of the species.

The Apical or Genital Disc.

The apical disc occupies the centre of the summit of the test, and is composed in most genera of ten plates, namely, five genital plates and five ocular plates (Pl. VI, fig. 1, *a*). In the *Salenidæ* there is one or more additional plates introduced. *The five genital* or *oviductal plates* correspond to the summits of the inter-ambulacral areas; two plates form an antero-lateral pair, two a postero-lateral pair, and the single plate is placed behind. On the right antero-lateral genital plate (Pl. VI, fig. 1, *a*) is a spongy, prominent mass, called the *madreporiform body*; the plate supporting this body was supposed by Agassiz and Desor always to represent the posterior part of the test, but I have shown that it is invariably placed on the right antero-lateral plate.

The ocular plates are at the summit of the ambulacral areas; they are small, heart-shaped bodies (Pl. VIII, fig. 4, *b*), wedged into the angles of the genital plates around the circumference of the disc.

The suranal plates are found only in the *SALENIDÆ*; they consist of one or many elements placed in the centre of the genital circle, and always before the anal opening.

The anal plates (Pl. VIII, fig. 4, *b*), are very small bodies, and variable as to number; they clothe the membrane of the anal opening, and are well seen in recent urchins; but

are seldom preserved in fossil species; they are admirably shown, however, in the fine specimen of *Cidaris subvesiculosa* (Pl. VIII, fig. 4), from the collection of our kind friend, Dr. Bowerbank, F.R.S.

The Tubercles.

The plates composing the test of the *Cidaridæ*, *Echinidæ*, and *Salenidæ*, have large tubercles developed on their surface; they are divided into *primary tubercles*, *semi-tubercles*, *secondary tubercles*, *minute tubercles*, *granules*, and *miliary granulation*. In the other families the tubercles are smaller, more numerous, and less complicated.

The *primary tubercles* form two rows in the inter-ambulacral areas of the *Cidaridæ*, (Pl. I and II), and four, six, eight, ten, or twelve rows in many *Echinidæ*.

The *semi-tubercles* are found at the base of the ambulacral areas of the genus *Hemicidaris*. In a section of the genus *Hemipedina* they likewise are found at the base of the ambulacra.

The *secondary tubercles* are found in many of the *Echinidæ*, ranged, in general, on the ambulacral side of the primary tubercles. They are found likewise on the centro-sutural side of the primary rows of many *Pseudodiadema*, *Pedina*, *Hemipedina*, and *Echinus*.

The *minute tubercles* are the small tubercles found on the margins of the ambulacral areas of the genus *Cidaris* (Pl. VIII, fig. 1); and they sometimes fill up spaces at the base of the inter-ambulacral areas. In some *Pseudodiademata* they are raised on little eminences, and perforated like the secondary and primary tubercles. In this respect they are distinguished from the granules.

The *granules* are small, round, hemispherical elevations, scattered more or less regularly over different parts of the plates of the test. In some species of the genus *Cidaris* they are arranged in rows in the centre of the ambulacral areas, or form circles around the circumference of the areolas of the primary tubercles (Pl. VIII).

The *miliary granulation* is formed by a number of small granules closely set together in the centre of the ambulacra, or on the inter-tubercular surface of the large plates composing the inter-ambulacra (Pl. VIII, fig. 1).

The primary tubercles of the genera *Cidaris*, *Hemicidaris*, *Pseudodiadema*, *Hemipedina*, *Pedina*, &c., consist of the following parts:

The *hemispherical tubercle*, or *mamelon*, is sometimes perforated in the centre, sometimes imperforate, as in many *Echinidæ* (Pl. VII, fig. 3 c).

The *boss*, or *mammillary eminence*, is the conical prominence on the surface of the tubercular plate; its summit supports the tubercle, and the margin thereof is crenulated in *Hemicidaris* and *Pseudodiadema*, and smooth in *Hemipedina* and *Pedina*.

These characters are important for generic distinctions.

The *areola*, or *scrobicule* (Pl. VI, fig. 1, *d*), is the round, oval, or elliptical, smooth, excavated space which surrounds the base of the boss. This space is sometimes narrow, and its margin elevated into a ridge, that completely encircles it, when the *scrobicule* or *areolar circle* is said to be *complete*; if the upper and under sides of the circle are wanting, it is *incomplete*, and the areolas are then said to be *confluent*.

The row of granules encircling the areolas is called the *areolar* or *scrobicular circle*.

The *miliary zone* is the space comprised between two ranges of primary tubercles, it is in general covered with a close-set granulation; when destitute of miliary granules, it is said to be *naked*; the ambulacral and inter-ambulacral miliary zones occupy these different regions of the shell.

When the granules are microscopic, and closely clustered together within certain narrow, circumscribed bands, or *fascioles*, intersecting the general tubercular surface, and occupying fixed positions on the test, they are called *fasciolar*.

Fascioles are only found in two families, in one genus of the *Echinocoridae*, and in almost all the genera of the *Spatangidae*. The form, width, structure, and position of these bands must be carefully noted, as they afford important characters, both positive, and negative, for the diagnosis of the genera.

When a fasciole surrounds the circumference of all the petaloidal portions of the ambulacral areas, it is *peripetalous*; if it encircles the single ambulacrum alone, it is *internal*; when it extends along the flanks, it is *lateral*; if it passes in whole, or in part, along the circumference, it is *marginal*; and when it surrounds the base of the single inter-ambulacrum, it is *subanal*. Sometimes there is only *one*, sometimes there are *two* or *three*, of these fascioles in different genera.

Each family has a special arrangement of the tubercles, granules, and fascioles; a detailed account of these will be found in the general outline of the structural characters prefixed to the description of each natural group.

The *sutural impressions* are the lines along which the plates are united together; sometimes they are mere lines; or the impressions amount to excavations out of the borders of the plates, and give rise to cavities therein, as in the genus *Temnopleurus*.

The *angular* or *sutural pores* are small impressions, situated in some genera at the angles of the plates, upon the median line of the miliary zones.

The external Appendages of the Test.

The *spines*, or *radioles*, as they were called by Plott, Lang, and other old authors, are the calcareous appendages that are moveably articulated to the tubercles of the test; they present numerous modifications as to size, form, and sculpture, which are all intimately

connected with specific characters ; some are short or elongated, flattened, cylindrical, fusiform, or subulate ; others are compressed, spatuliform, or triangular ; others, on the contrary, are expanded, pyriform, or claviform. The surface of the spines is smooth or striated with fine or coarse longitudinal lines ; some have verticillate processes at regular intervals, others have asperities, prickles, or granules, disposed with more or less regularity over the surface. The different parts of the spine have received the following names :

The *articular cavity*, or *acetabulum*, is the socket by which the spine articulates with the tubercle ; its margin is smooth or crenulated, according as the summit of the boss is smooth or crenulated (Pl. VI and VII) ; in all the genera with perforated tubercles there is a corresponding pit in the socket of the spine, for the attachment of the round ligament which passes from the tubercle to the spine.

The *head* is that part of the spine containing the articulating cavity, and is united to the stem near the neck (Pl. VII, fig. 4).

The *milled ring* surrounds the head ; it is a prominent ridge, more or less deeply crenulated, around which the muscular fibres that move the spine are firmly attached.

The *neck* is the smooth space between the line of junction above the milled ring and the rugose body of the spine (Pl. VII and VIII). In long, slender, tapering spines, it is often finely striated with longitudinal lines, and cannot be distinguished from the body into which it passes.

The *stem* or *body of the spine* is the part that exhibits the greatest variety of forms, smooth and muricated varieties are figured in Pl. I, II, IV.

The organs of mastication forming "the lantern of Aristotle" are rarely preserved in fossil species ; they consist of five jaws, each carrying a long tooth (Pl. V and VII). As these parts form a complicated mechanism, their analysis and description will be given at length in the anatomical part of the introduction.

On the relative value of the external organs in the classification of the Echinoidea.

The mouth is always basal, central, subcentral, or excentral, but the excentricity is invariably towards the anterior border. This opening does not, therefore, afford a character of primary importance, although, in connection with others, it is valuable in the definition of families. The mouth is sometimes armed with jaws, but it is oftener edentulous.

The position of the anal opening affords a character of primary importance. In one great section the vent opens *within* the centre of the apical disc, surrounded by the genital and ocular plates. The relation, therefore, of the digestive organs to those of generation and vision, is an important primary character for the zoologist. In another section the vent opening is *without* the apical disc, and is more or less external to, and at a greater or less distance from, the genital and ocular plates. The physiological importance of the external relation of the organs of digestion, generation, and vision, to each other, imparts great

value to the position of the anal opening ; and hence it forms the basis of the subdivision of this order into two sections, which are thus defined :

Echinoidea endocyclica.

- A. Test circular, spheroidal, more or less depressed, rarely oblong ; mouth in the centre of the base. Vent in the centre of the upper surface, directly opposite to the mouth, surrounded by five perforated genital plates, and having external to them five ocular plates. Mouth always armed with five powerful calcareous jaws, formed of many elements, disposed in a vertical direction.

Echinoidea exocyclica.

- B. Test sometimes circular and hemispherical ; oftener oblong, pentagonal, depressed, clypeiform, or discoidal ; mouth central or ex-central. Vent external to the circle of genital and ocular plates, never opposite the mouth, and situated in different positions in relation to that opening : four of the genital plates are generally perforated. The mouth is sometimes armed with five jaws, oftener it is edentulous. The elements of the lantern are disposed in a more or less horizontal direction.

The structure of the ambulacral areas, and poriferous zones, afford good characters of secondary importance for grouping the genera into natural families, especially when taken in connection with the position of the vent, which varies in its relation to that of the mouth-opening in different families.

The form, number, and arrangement of the tubercles, and the spines that are jointed with them ; the miliary granulation ; the bands of microscopic granules forming the fascioles, having permanent positions on the test ; also the size and number of the elements of the apical disc, and the position of the vent, afford collectively good characters for defining the genera.

The minute details of the structure of the plates ; the form, size, and number of the tubercles on each of them ; the arrangement of the pores, their proximity or remoteness from each other in the zones ; the general outline of the test, which has only certain limits of variation ; the form of the areolas ; the presence, absence, size, and distribution, of the granules forming the scrobicular circle ; the completeness or incompleteness of the same ; the length of the spines, their form and sculpture, are points affording good specific characters, as they are persistent details that are developed on every considerable fragment of the test and spines of the Echinoideæ.

Taking these general principles for my guidance, I subdivide the Echinoidea into the following thirteen natural families :

Order—ECHINOIDEA.	<i>Echinoidea endocyclica.</i> Vent within the genital plates, always opposite the mouth.	Cidaridæ. Hemicidaridæ. Diademadæ. Echinidæ. Salenidæ. Echinoconidæ. Collyritidæ. Echinonidæ. Echinobrissidæ. Echinolampidæ. Clypeasteridæ. Echinocoridæ. Spatangidæ.
	<i>Echinoidea exocyclica.</i> Vent without the genital plates, never opposite the mouth.	

Family 1. CIDARIDÆ.—Test thick, spheroidal; inter-ambulacral areas very wide; primary tubercles large, perforated; bosses crenulated or uncrenulated, spines large, thick, mostly claviform; ambulacral areas very narrow; poriferous zones narrow, pores unigeminal, rarely bigeminal; mouth-opening large, inferior, central, circular or pentagonal; peristome destitute of notches, always armed with large, powerful jaws. Vent-opening wide, superior, opposite the mouth, surrounded by five large genital plates perforated for the ovarian canals, and five small ocular plates excavated for lodging the eyes; buccal and anal membranes covered with scales.

Types. *Cidaris clavigera*, König (Pl. IV). *Cidaris sceptrifera*, Mantell (Pl. VI).

Family 2. HEMICIDARIDÆ.—Test thick, spheroidal, or more or less depressed; ambulacral areas narrow or wide, with semi-tubercles at their base only, or extended throughout the area; inter-ambulacral areas with two rows of primary tubercles, rarely more than eight in each row; tubercles of both areas perforated, and bosses deeply crenulated; poriferous zones narrow and undulated; pores unigeminal throughout, except near the peristome, where they are bigeminal and trigeminal. Mouth-opening large; peristome decagonal, and divided more or less deeply by notches into ten lobes; jaws large and powerful; apical disc small, opposite the mouth, composed of five genital and five ocular plates. Spines long, thick, cylindrical, tapering, claviform, or stout, compressed, or angular; surface smooth, or covered with fine longitudinal lines, as far as known, neither prickles nor asperities are developed thereon.

Types. *Hemicidaris intermedia*, Fleming. *Acrocidaris formosa*, Agassiz.

Family 3. DIADEMADÆ.—Test thin, circular, or pentagonal, more or less depressed;

ambulacral areas wide, with two or four rows of primary tubercles; inter-ambulacral areas with two, four, six, or more rows of tubercles, nearly of the same size and structure as those of the ambulacra; tubercles perforated or imperforated, crenulated or uncrenulated, in different genera; apical disc small, opposite the mouth, composed of five genital and five ocular plates; poriferous zones narrow; pores unigeminal or bigeminal. Mouth-opening large and decagonal; peristome divided into ten lobes by deep notches; spines long, cylindrical, more or less slender, either tubular or solid; sometimes encircled by spiral verticillate processes, or their surface is sculptured with fine longitudinal lines.

Types. *Astropyga radiata*, Leske. *Cyphosoma Koenigii*, Mantell. *Pseudodiadema tumidum*, Forb.

Family 4. ECHINIDÆ.—Test thin, spheroidal; inter-ambulacral areas, with small primary tubercles, of various sizes, perforate or imperforate; bosses crenulate or uncrenulate; ambulacral areas wide, always supporting two or more rows of primary tubercles; poriferous zones narrow or wide, pores unigeminal, trigeminal, or polygeminal, and disposed in arcs; spines short, mostly subulate. Mouth-opening large, inferior, always decagonal; peristome divided into lobes by notches more or less deep. Vent small, superior, opposite the mouth, surrounded by five genital and five ocular plates; buccal membrane naked.

Types. *Echinus sphæra*, Müller. *Codiopsis Doma*, Desmarest.

Family 5. SALENIDÆ.—Test thin, spheroidal; inter-ambulacral areas wide, with few primary tubercles, either perforate or imperforate, crenulate or uncrenulate; ambulacral areas narrow, carrying secondary tubercles. Mouth-opening small or large, inferior, decagonal; peristome more or less notched. Vent superior, surrounded by the plates of a large apical disc, composed of more than ten pieces, occupying a wide aperture in the superior part of the test. Poriferous zones narrow, pores unigeminal, except near the peristome, where they are trigeminal. Spines long, subulate, circular, or flattened. Species all extinct; the genera distributed in the Oolitic, Cretaceous, and Tertiary rocks.

Types. *Salenia petalifera*, DeFrance. *Acrosalenia hemiciaroides*, Wright. *Goniorphus lunulatus*, Agassiz. *Hyposalenia Wrightii*, Desor.

Family 6. ECHINOCONIDÆ.—Test thin, circular, elongated or pentagonal, elevated or depressed; inter-ambulacral areas wide, ambulacral areas narrow; external surface of the plates covered with numerous small, perforated, and crenulated tubercles; poriferous zones narrow, pores unigeminal, except near the base, where they are trigeminal. Mouth-opening inferior, central, circular, or pentagonal, armed with five jaws; peristome

notched, dividing the circumference into ten nearly equal lobes. Apical disc central, superior, composed of five genital and five ocular plates; madreporiform body large, extending from the right antero-lateral genital plate into the centre of the disc. Vent situated at the upper surface, in the margin, or at the inferior surface of the test. Spines small, short, subulate. Species all extinct; genera distributed in the Oolitic and Cretaceous rocks.

Types. *Echinoconus albo-galerus*, Klein. *Pygaster semisulcatus*, Phillips. *Discoidea cylindrica*, Lamarck.

Family 7. COLLYRITIDÆ.—Test thin, circular, or oval; ambulacral areas meeting at two points, more or less apart, on the upper surface; poriferous zones narrow, pores unigeminal; tubercles small, numerous, perforated, and crenulated. Mouth-opening ex-central, small, round, oval; peristome feebly fissured; jaws unknown. Vent round, oval, supra-marginal; elements of the apical disc detached; four genital holes. Species all extinct, and distributed in the Oolitic and Cretaceous rocks.

Types. *Collyrites ringens*, Desmoulins. *Collyrites ovalis*, Parkinson.

Family 8. ECHINONIDÆ.—Test thin, oval; poriferous zones narrow, meeting at the apical disc; pores unigeminal; tubercles of both areas nearly equal, neither perforated nor crenulated; spines stout, subulate. Mouth-opening nearly central, irregularly pentagonal, and edentulous. Vent oblong or pyriform, basal or marginal, closed by anal plates; apical disc nearly central; four genital pores. One group living in tropical seas; another fossil in the Cretaceous rocks.

Types. *Echinoneus cyclostomus*, Leske. *Pyrina Desmoulinsii*, D'Archiac.

Family 9. ECHINOBRISIDÆ.—Test thin, circular, oblong, sub-pentagonal or clypeiform, covered with microscopic perforate tubercles, surrounded by excavated areolas; ambulacra narrow, enclosed by poriferous zones, more or less petaloidal; pores set at different distances apart, and united by connecting sutures. Mouth-opening small, nearly central, pentagonal, edentulous, in general surrounded by five lobes. Vent, opening in a sulcus, in the upper surface of the single inter-ambulacrum, or in a marginal depression thereof; apical disc small, four genital plates; madreporiform body extending into the centre of the disc. Species living and extinct, the latter distributed in the Oolitic, Cretaceous, and Tertiary rocks, the former in the seas of New Holland, and the Antilles.

Types. *Echinobrissus clunicularis*, Llhwyd. *Clypeus Plotii*, Leske. *Catopygus carinatus*, Goldfuss. *Pygaulus cylindricus*, Desor.

Family 10. ECHINOLAMPIDÆ.—Test thin, oblong, oval, elevated, or sub-discoidal; ambulacra large, petaloid; poriferous zones wide; pores apart, and united by suture; zones extending near to the margin. Mouth small, surrounded by five lobes,

Vent transversely oblong, and infra-marginal; apical disc small, excentral, with four genital holes. Some species are now living in warm seas, but the greatest number are extinct, and distributed in the Oolitic, Cretaceous, and Tertiary rocks.

Types. *Conoclypus Leskei*, Goldfuss. *Echinolampas orientalis*, Gray. *Pygurus Koenigi*, Gray.

Family 11. CLYPEASTERIDÆ.—Test thick, elevated or depressed, circular, elliptical, or pentagonal; surface closely covered with small, nearly equal-sized tubercles, sunk in the plates, and surrounded by ring-like areolas, tubercles carrying short hair-like spines. Mouth large, central, and pentagonal, armed with five strong jaws, containing the same number of teeth. Vent posterior, marginal or infra-marginal; interior of the test divided by pillar-like processes, formed of the inner layer of the plates. The dorsal portions of the ambulacral areas have a petaloid form, circumscribed by large poriferous zones; the basal portions are narrow, rectilineal, or branched; the five genital plates form a circle round the madreporiform body, and between these are wedged the five ocular plates. This family includes the genera *Clypeaster*, Lamk., *Laganum*, Klein, *Echinarachnius*, Van Phels., *Arachnoides*, Klein, *Scutella*, Lamk., *Dendraster*, Agass., *Lobophora*, Agass., *Encope*, Agass., *Echinodiscus*, Breynius, *Mellita*, Klein, *Runa*, Agass., *Moulinsia*, Agass., *Scutellina*, Agass., *Echinocyamus*, Van Phels., *Fibularia*, Lamk., *Lenita*, Desor.

Types. *Clypeaster rosaceus*, Lamarck. *Scutella subrotunda*, Lamarck. *Echinarachnius placenta*, Gmelin.

Family 12. ECHINOCORIDÆ.—Test thick, oval or cordate, and sometimes conoidal; ambulacral areas contracted; poriferous zones narrow, pores unigeminal; test covered with small perforated and crenulated tubercles. Mouth small, excentral, transversely oblong. Vent nearly of the same size, oblong, marginal or supra-marginal. Apical disc elongated, nearly central, with four genital pores; the cordate forms have an anterior central depression, and one genus has a marginal fasciole. The species are all extinct, and limited to the Cretaceous rocks.

Types. *Echinocorys vulgaris*, Breynius. *Holaster subglobosus*, Leske. *Cardiaster granulosus*, Goldfuss.

Family 13. SPATANGIDÆ.—Test thin, oval, oblong or cordiform, exhibiting the bilateral symmetry of the Echinoidea. Vent posterior and supra-marginal, closed by a complicated series of small plates. Apices of the ambulacral areas united at the summit of the test. The single ambulacrum has a different structure from the antero- and postero-lateral pairs, and is lodged in general in a depression of the test, which extends to the anterior border, and forms the anteal sulcus; test extremely thin, and covered with small tubercles, which support hair-like spines. Besides these there are some larger

crenulated and perforated tubercles for supporting large spines. There are two or four genital pores, placed close together in some genera, but apart in others. The eye-plates, five in number, are situated at the apices of the ambulacra, in a pentagonal form, around the genital plates. On the surface of the test of some *Spatangidæ* certain delicate lines are observed, having a smoother appearance than the tubercular surface of the test; these are the *fascioles*, which are strewed with microscopic tubercles, and destined to carry very delicate spines. The fascioles have a different disposition in each genus, and afford a good character in making definitions of the same. When the fasciole surrounds the ambulateral petals like an undulating groove, as in *Hemiaster*, *Schizaster*, &c., it is *peri-petalous*; when it surrounds the single ambulacrum, as in *Amphidetus*, it is *internal*; when it extends along the sides, as in *Schizaster*, it is *lateral*; when it surrounds the circumference of the test, as in *Pericosmus*, it is *marginal*; when it is limited to the base of the anal opening, it is *sub-anal*. Sometimes, in the same genus, more fascioles than one exist; thus the sub-anal and peri-petalous are frequently associated together.

Types. *Spatangus purpureus*, Müller. *Brissus lyrifer*, Forbes. *Brissopsis Duciei*, Wright.

Family 1—CIDARIDÆ.

Test thick, turban-shaped, more or less depressed at the oral and anal apertures. Mouth-opening wide, central; peristome circular or pentagonal, without notches; aperture closed by a buccal membrane, covered with small spines, metamorphosed into imbricated scales, upon which the pores from the zones are prolonged.

Opening for the apical disc very large; disc composed of five large, equal-sized, angular, genital plates, and five ocular plates; vent opening in the centre, directly opposite the mouth; anal membrane clothed with small angular plates, unequal in size, and variable in number.

Ambulacral areas extremely narrow, composed of a great number of very small plates, having only minute tubercles, or rows of small granules on their surface, and never supporting tubercles with primary spines.

Inter-ambulacral areas very wide, composed of large plates, rarely more than from six to eight in a column; the external surface of each plate carries a large perforated tubercle, raised on a prominent boss, and encircled by a round or oval areola, having an elevated margin, on which are a circle of granules, usually larger than those filling the miliary zone.

Poriferous zones narrow, extending without interruption from the margin of the buccal membrane to the apical disc; pores in general unigeminal, in one genus bigeminal; pores contiguous, or separated by septa more or less thick.

Jaws, five in number, forming a very powerful lantern, moveably connected with, and supported by, a series of calcareous processes or auricles, arising from the inner surface of the test; the teeth are more simple, and the lantern less complicated than in the *Echinidæ*.

The spines in this family exhibit a great variety of forms, they are large, strong, cylindrical, fusiform, prismatic, club-shaped, or flattened; and their surface is covered with fine longitudinal lines, or with prickles or granules, having in general a linear arrangement, or a more or less irregular disposition; the form and sculpture of the spine has a specific value, as its dominant characters appear to be persistent.*

The *Cidaridæ* are the most ancient type of the Echinoidea. The remains of different forms of this family are found in the Palæozoic rocks, as well as in those of the Secondary

* The form and general character of the spine should, in every case, be examined with scrupulous attention, and, whenever in fossil species the spines are found attached to their test, the facts connected therewith should be noted with the greatest accuracy. The neglect of this caution has been the cause of much confusion, and led to some serious errors.

and Tertiary epochs. In his valuable Synopsis, M. Desor describes six genera in this family: these are *Cidaris*, Klein; *Rabdocardis*, Desor; *Diplocidaris*, Desor; *Porocardis*, Desor; *Goniocardis*, Desor; *Palæocardis*, Desor. Of this number three are extinct—*Diplocidaris*, *Porocardis*, and *Palæocardis*; two contain both extinct and living forms—*Cidaris* and *Rabdocardis*; and one is only found living—*Goniocardis*.

A.—*Species from the Gault.*

CIDARIS GAULTINA, *Forbes*, MS. Pl. I, fig. 2, *a, b, c, d, e*; fig. 3, *a, b*; fig. 4 *a, b, c*.

CIDARIS GAULTINA, *Forbes*. Morris's Catalogue of British Fossils, 2nd ed., p. 74, 1854.

— — Woodward. Memoirs of the Geological Survey, Decade v, expl., pl. v, 1856.

The specimen figured in Pl. I, fig. 2, belongs to the British Museum, and was kindly communicated by my friend, S. P. Woodward, Esq., F.G.S. It consists of five interambulacral plates, and a trace of an ambulacral area, with a number of spines. Detached plates of this urchin resemble those of *Cidaris vesiculosa*, Goldf. In the large plate (fig. 2, *b*), magnified two and a half times, the depth is greater than the breadth; the wide circular areola is nearer the lower border, its margin is elevated, and surrounded by a circle of thirteen small tubercles, each set upon a distinct base; the boss is flat, its summit smooth, and the tubercle large and distinctly perforated; the rest of the plate is covered with a fine close-set granulation (fig. 2, *a, b*).

The remaining fragment of the ambulacral area is too imperfect for description.

The spines vary in form; they are in general long and slender, and taper slightly (figs. 2 and 3). The surface is covered with longitudinal ridges, the edges are distinctly serrated (fig. 2, *a*, and fig. 3, *b*), and the stem represents a miniature fluted column. The truncated summit shows a star-like structure (fig. 2, *c*), produced by the serrated ridges meeting around the circumference of a central circle. The neck is smooth, short, and thick (fig. 2, *d*, and fig. 3, *b*); the milled ring broad and flat, and covered with very fine lines; the head is short, and the acetabulum surrounded by a line (fig. 2, *d*).

In one of the broken spines that accompanies the plates the upper extremity is expanded and cup-like (fig. 4, *a, b, c*), whilst in the other spines the extremities are contracted and truncated (fig. 2, *a, c*).

Affinities and differences.—This urchin very closely resembles *Cidaris vesiculosa*, Goldf., found in the Chalk-marl of Essen and Ruhr. The resemblance is so great between the German and English forms, that without a comparison of specimens a correct diagnosis

cannot be given. In *Cidaris vesiculosa*, Goldf., the marginal circle of areolar tubercles is not so prominent as in *Cidaris Gaultina*, Forb., but the general character of the ornamentation on the plates is the same in both. The spines figured by Goldfuss closely resemble those of *C. Gaultina*; they have the same slender, elongated form, and fluted structure; most of them are spindle-shaped, and some have an expanded cup-like termination, like the spine fig. 4, *a*.

Locality and Stratigraphical Position.—*Cidaris Gaultina* is a very rare urchin. I only know the specimens contained in the Museum of the Royal School of Mines, and the subject of our figures, which belongs to the British Museum; both these fossils were obtained from the Gault at Folkstone. *Cidaris vesiculosa*, Goldf., on the contrary, has been collected from the Chalk-marl of Germany, and the Grey Chalk at Dover.

B.—*Species from the Upper Greensand.*

CIDARIS VELIFERA, *Bronn*. Pl. II, fig. 2 *a, b, c, d, e, f*; fig. 3 *a, b*; fig. 4 *a, b*.

- CIDARIS VELIFERA, *Bronn*. Jahrb., p. 154, the name only, 1835.
- PISIFERA, *Agassiz*. Catalogus Systematicus, p. 10, 1840.
- VELIFER, *Bronn*. Index Palæontologicus ("= *Salenia* sp."), 1848.
- MICHELINI, *Sorignet*. Ours. Foss. de l'Eure, p. 18, 1850.
- GLOBICEPS, *Quenstedt*. Handbuch der Petrefactenkunde, p. 577, pl. 49, fig. 17, 1852.
- VELIFERA, *Woodward*. Mem. Geol. Surv., Decade v, pl. v, 1856.
- HEBERTI, *Desor*. Synopsis des Échinides Fossiles, p. 12, 1858.
- VELIFERA, *Desor*. Ibid., p. 34, 1858.
- — *Cotteau*. Paléont. Française; Echinides, pl. 1054, figs. 14—21, p. 241.

Test small, circular, depressed; ambulacral areas narrow and sinuous, with four rows of granules; inter-ambulacral areas wide, tubercles large and prominent, gradually increasing in size from the peristome to the apical disc, where they are globose and conspicuous; spines short, stems large and globular, surface covered with longitudinal rows of pustular elevations.

Dimensions.—Height, three tenths of an inch; transverse diameter, eleven twentieths of an inch.

Description.—This beautiful little *Cidaris* is one of the oldest representatives of the group possessing claviform spines, *Radioli glandarii*, for all doubt about the identity of the

test, and the spine appertaining thereto, is removed by the discovery of the interesting specimen figured in Pl. II, fig. 4, *a*. The spines of this species were first discovered in the Craie chloritée of Essen and Frohnhausen, and were named by Bronn *velifer*; as the asperities on their globular stem impart a peculiar character to them, and that author, in his 'Index Palæontologicus,' referred them to a *Salenia*. M. Desor described a small *Cidaris Heberti* from the Craie chloritée of Cap la Hève, which I believe to be the test of this species. The short diagnosis given in the 'Synopsis' agrees so well with the specimens before me that I have no hesitation in concluding it to be the same:—"Petite espèce à scrobicules petits et serrés, mais à tubercules très-gros, surtout à la face supérieure. Quatre rangées de granules ambulacraires."

The ambulacral areas are slightly sinuous, and furnished with four rows of small granules (fig. 2, *e*) closely set together, the marginal rows being the most uniform in their arrangement. The narrow poriferous zones lie in a deep groove formed by the prominence of the adjoining granules; the pairs of small holes are obliquely inclined, with thickened septa, each having a small tubercle (fig. 2, *e*) between them.

The inter-ambulacral areas have two rows of tubercles placed so near the poriferous zones that the inter-tubercular space in the middle of the area is about the same width as the ambulacra, whereby the ten rows of tubercles are situated nearly equidistant from each, thus imparting a regular appearance to this species (fig. 2, *c*, *b*). There are five tubercles in each row, which increase gradually in size from the peristome to the disc; the three basal tubercles are small and set closely together (fig. 2, *b*), whilst the two upper tubercles are large and wide apart (fig. 2, *c*); the mammillary eminence is depressed, the areolæ are narrow (fig. 2, *e*), and their margin surrounded by a circle of well-defined granules (fig. 2, *f*). The tubercle is large and prominent, and the narrow boss on which it rests is destitute of crenulations (fig. 2, *e*, *f*); the summits of all the tubercles are perforated, those on the upper part of the test are, however, best preserved. A broad band of granulations separates the two rows of tubercles; five or six rows of granules are closely placed together; and the granules in the band and those in the ambulacra are nearly of the same size.

In the specimen figured at 4, *a*, there are seven spines attached to the test in their natural order. The spines (fig. 3, *a*) have a very short neck and a large globular stem, covered with rows of pointed elevations (fig. 3, *b*) rising from the midst of an apparently villous surface. The milled ring (fig. 4, *b*) is close to the acetabulum, it is moderately prominent, and crowded with fine lines. From the manner in which these globular spines are arranged on this small test, very little individual motion was possible among them, and yet the delicate surface of the spines, when examined with a lens, gives no evidence of abrasion, from the friction of moveable bodies laid so closely together as these spines were placed.

Affinities and differences.—The test of this beautiful little *Cidaris* is nearly related to

Cidaris clavigera, König, both in the form of the tubercles and the narrowness and depth of the areolæ; but in the structure of the spines there is a manifest difference, which will be more fully appreciated by comparing Pl. IV, fig. 1, exhibiting a series of spines of *C. clavigera*, with Pl. II, fig. 3, *b*, showing a magnified view of the spine of *C. velifera*.

Locality and Stratigraphical Position.—W. Cunnington, Esq., F.G.S., of Devizes, to whom I am indebted for the loan of specimens of this species, obtained them from the Upper Greensand near Warminster; I had seen the plates of the test and portions of the spines, but never before have I seen these parts “in situ.”

The foreign distribution of this urchin is as follows:—The spines are found in the Craie chloritée of Essen, Prussia, and of Frohnhausen, Hesse-Cassel, and the test, described under the name *Cidaris Heberti*, Des., was collected from the Craie de Vendome, from the Craie chloritée du Cap la Hève and la Madeleine, near Vernon (Eure) in l'Étage Cénomanién, where it is very rare.

C.—*Species from the Grey Chalk.*

CIDARIS CARTERI, *Forbes*. Pl. I, fig. 1, *a, b, c, d, e, f*.

CIDARIS CARTERI,	<i>Forbes</i> .	Memoirs of the Geol. Survey, Decade v, pl. v, 1854.
—	—	<i>Morris</i> . Morris's Catalogue of Brit. Fossils, 2nd ed., p. 74, 1856.
—	—	<i>Desor</i> . Synopsis des Échinides Fossiles, p. 12, 1858.

Test small, inflated, subconical; ambulacral areas narrow, winding, with two marginal rows of moniliform granules, and a deep median sulcus; inter-ambulacral areas wide; tubercles small, remote; areolæ at the equator narrow, complete, those on the upper plates small, elongate, and obsolete.

Dimensions.—Height, eight lines; transverse diameter, ten lines.

Description.—Should subsequent discovery confirm the opinion that this is an adult test, it will be the smallest *Cidaris* in the English Chalk. It very much resembles, in many points of structure, *Cidaris sceptrifera*, Mant., from which it differs, however, in size and figure, and in the development of the tubercles and their areolæ, especially those on the upper plates. The ambulacral areas are narrow and winding; they have two rows of prominent moniliform granules on the extreme margins of the areas (fig. 1, *c*); and in the depth of one equatorial inter-ambulacral plate I have counted sixteen of these; between them is a deep sulcus, on which two indistinct central rows of microscopic granules are sparsely distributed.

The inter-ambulacral areas are wide, and consist of large, deep plates (fig. 1, *c*), about four or five in each row, those at the equator are the largest; the tubercle is small and perforated; the boss is flat, with a smooth summit; the areolæ are narrow and complete, and encircled by a moniliform circle of sixteen small granules, raised on scale-like plates (fig. 1, *c*); from the equator to the mouth the tubercles and their areolæ gradually diminish in diameter, and on the upper surface the plates they are very deep, and their areolæ small, elongated, and entirely obsolete; the inter-tubercular surface of the plates is covered with close-set miliary granulations.

The poriferous zones are narrow and deeply sunk, in consequence of the thickness of the plate-ornamentation; the holes are small, the pairs oblique, and there are sixteen pairs opposite one large inter-ambulacral plate, one pair of holes being opposite one of the large marginal ambulacral granules.

The apical disc is wide, occupying all the summit of the test (fig. 1, *a*, *b*); the ovarian plates are large (fig. 1, *d*), and of an irregular rhomboidal figure; their surface is covered with small granules sparsely distributed thereon, and the oviductal holes are perforated at the outer third of the plates. The oculars are small and heart-shaped, and intercalated between the angles formed by the ovarials; the orbits appear to have been marginal.

Affinities and differences.—This species resembles *Cidaris sceptrifera*, Mant., but the depth of the inter-ambulacral plates and the limited number in a column, together with the smallness of the areolæ and the obsolete character of those on the upper plates, prove that this urchin is quite distinct from that form.

Locality and Stratigraphical Position.—The only specimen at present known was collected by James Carter, Esq., F.G.S., of Cambridge, from the Grey Chalk of that neighbourhood; and it belongs to his collection. In Morris's 'Catalogue' it was stated by mistake to have come from the White Chalk, and in M. Desor's 'Synopsis,' from the Grès vert supérieure d'Angleterre.

History.—This species was first figured in the 'Memoirs of the Geological Survey,' in plate v of the Fifth 'Decade of British Organic Remains.' The original specimen formed the subject of Mr. Bone's drawings for this work.

CIDARIS VESICULOSA, *Goldfuss*. Plate II, fig. 5, *a, b, c, d*; Plate III, fig. 1, *a, b, c, d, e*.

- CIDARIS VESICULOSA, *Goldfuss*. Petref. Germaniæ, t. i, p. 120, pl. xi, fig. 2, 1826.
- — *Agassiz*. Prod. Mém. Soc. Nat. de Neuchatel, tom. i, p. 188, 1836.
- — *Desmoulins*. Études sur les Échinides, p. 332, No. 23, 1837.
- — *Bronn*. Lethæa Geognostica, p. 607, pl. xxix, fig. 76, 1837.
- — *Geinitz*. Charakter der Schichten und Petrefacten Kreidegebirges, p. 89, pl. xxii, fig. 1, *a, b, c, d*, 1839.
- — *Roemer*. Norddeutschen Kreidegebirges, p. 28, 1840.
- — *Dujardin*, in Lamarek, Anim. sans Vert., 2e ed., t. iii, p. 338, 1840.
- — *Reuss*. Versteinerungen der Böhm. Kreideform., p. 57, pl. xx, fig. 14, 1845.
- — *Agassiz et Desor*. Catal. rais. des Éch. Ann. des Sc. Nat., 3e série, t. vi, p. 328, 1846.
- — *Bronn*. Index Palæont., p. 301, 1848.
- — *Quenstedt*. Handbuch der Petrefactenkunde, p. 575, pl. xlviii, fig. 47, 1852.
- SPINULOSA, *Guéranger*. Essai d'un rèp. paléont. de la Sarthe, p. 40, 1853.
- VESICULOSA, *Desor*. Synopsis des Échinides Fossiles, p. 11, pl. v, figs. 24, 25, 1855.
- RÆMERI, *Cotteau*, in Davoust, Note sur les Fossiles spéciaux à la Sarthe, p. 49, 1855.
- VESICULOSA, *Pictet*. Traité de Paléont., 2nd ed., t. iv, p. 254, 1860.
- — *Cotteau et Triger*. Échinides de la Sarthe, p. 133, pl. xxv, figs. 1—6, 1860.
- — *Cotteau*. Note sur les Échinides recueillis en Espagne, par MM. Verneuil, Triger, et Collomb., Bull. de la Soc. Géol. de France, 2e série, t. xvii, p. 375, 1860.
- — *Cotteau* in D'Orbigny's Paléontologie Française, t. ii, p. 222, pl. 1050, and pl. 1051, figs. 1—6.

Test circular, inflated, nearly equally depressed at both poles; ambulacral areas flexed, depressed in the middle, and filled with from six to eight rows of close-set, nearly equal-sized granules, diminishing to two or four rows near the disc and peristome; poriferous zones very narrow, and flexuous; pores small, having a moniliform line of granules separating the pores; inter-ambulacra wide, four to five plates in each column; tubercles moderate in size, perforated, and uncrenulated, set very wide apart on the upper half of the test; areas round, superficial, much inflated at the border, and surmounted with a circle of prominent, mammillated granules. Near the disc the tubercles on the alternate columns become dwarfed, are destitute of areolæ, and occupy the middle of a long granular plate; miliary zone large, much depressed, and filled with small equal-sized granules; discal and oral apertures about the same diameter.

Dimensions.—Height, nine tenths of an inch ; transverse diameter one inch and a half.

Description.—This urchin, which forms so characteristic a species in the Lower Chalk of the Continent, as shown in the table of synonyms, has hitherto escaped the notice of English geologists. The species from our Upper Chalk, erroneously referred to this form, being quite distinct from the true *Cidaris vesiculosa*, Goldf., from the Gray Chalk and Upper Greensand ; specimens from each of these formations I have figured in Pls. II and III.

The test is of moderate size, much inflated at the sides, and nearly equally depressed at both poles ; the ambulacral areas are flexuous, depressed in the middle, and filled throughout with numerous rows of small, regular, close-set, equal-sized granules ; at the equator there are eight rows, which, near their terminations, diminish to two or four rows (Pl. III, fig. 1, *d*) ; the inner rows are those which gradually disappear, whilst the outer rows are persistent throughout.

The poriferous zones are very narrow, following the flexures of the ambulacra ; they are composed of small round pores, separated by a granule, the series forming a moniliform line down the middle of the zone, fig. 2, *d*.

The inter-ambulacral areas are composed of very large plates, those in the upper half of the columns being the largest and most inflated ; there are from four to five plates in each series. The areas are circular and superficial, with very prominent borders surrounded by a circle of distinct regular mammillated granules (Pl. III, fig. 1, *d*) ; on the under half of the test the tubercles are approximated (Pl. III, fig. 1, *b*) ; whilst on the upper half they are set wide apart, from the increased height of the plates (Pl. III, fig. 1, *a* and *c*) ; near the summit the uppermost tubercles on the alternate columns are imperfectly developed, and often destitute of areolæ, and placed in the middle of a long granular plate (Pl. III, fig. 1, *a* and *c*). The tubercles are moderate in size, and perforated ; the summits of the bosses are quite smooth, and without any trace of crenulations (Pl. III, fig. 1, *e*).

The miliary zone is large and much depressed, and provided with numerous flat, uniform granules, closely set together on the entire surface of the plates (fig. 1, *d*).

The peristome is circular (fig. 1 *b*), and the opening for the apical disc (fig. 1, *a*) is nearly the same diameter as the oval aperture.

The spines of this species, according to M. Cotteau, are elongated, cylindrical, sub-fusiform, with compressed longitudinal ribs, more or less spinous, and denticulated, the processes being always at regular distances apart. Towards the base, the ribs diminish and disappear, and the stem is provided only with fine, close-set striæ. The neck is short and striated, the milled ring prominent, the articular head smooth, and surrounded by a small groove.

Length, twenty-five to thirty millimeters ; thickness, five millimeters.

Variety, *spinulosas*, Agassiz : length, forty-seven millimeters ; thickness, six millimeters.

Affinities and differences.—This species is distinguished from *Cidaris sceptrifera*,

Mant., of the White Chalk, by having fewer tubercles in the columns, which are wider apart in the upper portion of the test; the areolas are likewise shallower, and the border more prominent. In *Cidaris sceptrifera* the tubercles are largely developed (Pl. VI, VII), with deep areolas surrounded by a circle of prominent granules, and with a narrow sinuous miliary zone. The spines likewise are large and fusiform, having their surface covered with prominent spiny granules. *Cidaris vesiculosa*, Goldf., differs from *C. subvesiculosa*, d'Orbig., in having the test flatter, the tubercles smaller, less numerous, and more apart.

The specimens of this urchin, collected from the Upper Greensand of Wiltshire, were by the late Professor Forbes¹ referred to *Cidaris insignis*, Gras. Through the kindness of my friend W. Cunningham, Esq., F.G.S., I have been enabled to examine the beautiful series of this species in his collection, and in Pl. II, fig. 5, have figured his largest and finest specimen. A careful study of these fossils has satisfied me that they are not the species described by Dr. Albin Gras,² and which he thus characterized :—" Aires ambulacraires ondulées, paraissant présenter deux rangées verticales de granules très serrées et rapprochées les unes des autres; probablement cinq tubercles inter-ambulacraires non crénelés dans chaque rangée (quatre paraissent seulement dans notre exemplaire, dont la partie supérieure manque). Sur les cinq tubercles, les trois inférieurs augmentent progressivement de grandeur en allant de bas en haut; leurs scrobicules et leurs cercles scrobiculaires ronds, saillants et formés de granules serrés, sont très-prononcés, tangents entre eux et avec ceux de la rangée voisine; ils sont au contraire presque effacée dans le petit tubercle qui vient ensuite, lequel diminue brusquement et repose pourtant sur une très-large plaquette couverte de nombreux granules." The ambulacral areas in *C. vesiculosa*, Goldf., have, at the equator, six rows of small, equal-sized granules, closely arranged in parallel lines, and diminishing to four rows at the narrowest parts. This persistent structure affords a character by which the species is distinguished from *C. insignis*.

The British Museum contains a fine specimen of *C. vesiculosa*, Goldf., from the Gray Chalk of Dover (Pl. III, fig. 1). This test I have carefully compared with Mr. Cunningham's Upper Greensand specimens, and the examination has convinced me that they belong to the same species; the test of the specimen from the Gray Chalk is that of a larger, and older individual; some of the plates, however, in the upper part of the columns, are proportionally more inflated; but in all other respects its characters are identical with those of the Upper Greensand forms.

The test is spheroidal, of medium size, and nearly equally depressed at both poles; the ambulacral areas form narrow, flexuous, granular bands, which decline towards the central suture; they are entirely filled with small, close-set, equal-sized granules, arranged in regular parallel rows, of which there are from six to eight at the equator, diminishing to four in the narrowest parts, near the peristome and apical disc; the poriferous zones

¹ Morris, 'Catalogue of British Fossils,' 2nd ed., p. 74.

² 'Description des Oursins Fossiles du département de l'Isère,' p. 21, 1848.

are very narrow, and the small pores are placed close together, each septum being surmounted by a little granule; there are 23 pairs of holes opposite one of the large plates.

The inter-ambulacral areas are formed of large deep plates, the limits of which are very distinctly defined by well-marked sutural lines; there are four or five plates in each column, those at the lower part of the test are small and regular (fig. 1, *b*), and those at the upper part of the column are large, deep, and rather irregular in figure, from the extreme prominence of the areolar margin (fig. 1, *a, c*); each plate, with the exception of the uppermost in each alternate column, supports a large primary tubercle; it is surrounded by a shallow circular areola; the boss is not prominent; and the summit is smooth, without a trace of cre-nulation; the tubercle is large, sessile, and perforated (fig. 1, *c*); the margin of the areola is very prominent, which, in the larger plates especially, produces an inflation of their surface, and probably suggested the specific name *vesiculosa* (fig. 1, *a*). A complete circle of mammillated granules, larger than those on other parts of the test, surrounds the margin of the areolæ, and forms a prominent boundary thereto (fig. 1, *d*). The uppermost plate in each alternate column, in most specimens, is either destitute of a tubercle, or represented only by a rudimentary warty body, without areola, and situated in the midst of a long, narrow, imperfectly developed plate, on all sides surrounded by granules.

The mouth is small and circular, and of the same diameter as the aperture for the apical disc, which is likewise entirely circular.

Locality and Stratigraphical Position.—The specimen figured in Plate III, fig. 1, belonging to the British Museum, was collected from the Gray Chalk, at Dover, and the one figured in Pl. II, fig. 5, belongs to my friend W. Cunningham, Esq., F.G.S., Devizes, and was obtained from the Upper Greensand of Wilts. The specimen in my own collection is from the Gray Chalk of Dover. I believe this urchin is very rare, as I have seen very few specimens in the different collections of Cretaceous fossils. The Rev. T. Wiltshire, F.G.S., has communicated a fragment, collected from the Red Chalk of Hunstanton Cliff, together with three detached spines, of the same species. I am inclined to refer to this species the specimen, figured in Pl. III, fig. 3, collected by C. B. Rose, Esq., F.G.S., from the Red Chalk, and kindly communicated for this work. The test is much defaced by friction, but still many of the more remarkable characters of the urchin are well preserved.

History.—This urchin was figured and described for the first time by Goldfuss, from some isolated plates and spines collected from the *creta margacea* of Westphalia; that author cites, as identical with *Cidaris vesiculosa*, a fragment from the White Chalk of England figured by Parkinson, but which belongs to another species, probably *Cid. perornata*, Forb. This error has led to much confusion, for we find *Cid. vesiculosa*, Goldf., cited in many English lists as having been obtained from the White Chalk of Kent, Sussex, and Wilts; whereas the new form now figured and identified with Goldfuss's species has

been collected only from the Gray Chalk of Dover and the Upper Greensand of Wilts. *Cidaris vesiculosa*, Forbes, is a very different form from the true *C. vesiculosa*, Goldf. ; and I must refer the reader to the article on that species for more ample details. This species has been beautifully figured and well described by M. Cotteau, both in his Monograph on the Echinidæ of Sarthe, and his continuation of D'Orbigny's Échinides de Terrains Crétacés, in the Paléontologie Française, a work which has profited so much by M. Cotteau's extensive knowledge of this subject. This species has now been identified and figured as British for the first time.

CIDARIS BOWERBANKII, *Forbes*. Pl. II, fig. 1, *a—d*.

CIDARIS BOWERBANKII, *Forbes*, in Dixon's Geol. and Fossils of Sussex, pl. xxix, fig. 4, p. 330, 1850.

— — — *Forbes*, in Morris's Cat. of Brit. Foss., 2nd ed. p. 74.

Test spheroidal, depressed, ambulacral areas with four or six rows of nearly equal-sized granules ; inter-ambulacral areas wide, five or six large spinigerous tubercles, with small areolæ in each column ; miliary zone wide, filled with small, close-set, equal-sized granules. Spines very large, thick, and inversely conical, stems short, the surface covered with irregular, longitudinal rows of granulated spines.

Dimensions.—Transverse diameter one inch ; height unknown.

Description.—The body of this *Cidaris*, which is very nearly allied to *C. clavigera*, is more compressed above and below than in that species.

The ambulacral areas are occupied by four or six small, nearly equal, granular tubercles in each transverse row, and the poriferous zones are narrow and slightly sinuous.

The inter-ambulacral areas are wide ; the spinigerous tubercles, five or six in each column, have small areolæ, without prominent margins ; the miliary zone is flat, and undepressed ; and the entire surface is thickly covered with minute nearly equal-sized granules, of which a circle of larger ones surround the border of the areolæ.

The primary spines, seen *in situ* on the test (fig. 1, *a*), are thick, almond-shaped, inversely conical bodies, with a short neck, into which the body suddenly contracts (fig. 1, *b*) ; the milled ring is broad and prominent (fig. 1, *c*), and the acetabulum has a narrow rim close to the ring ; the surface is minutely granulated with small spinous points, arranged in regular longitudinal rows (fig. 1, *b*) ; the spines which clothe the granular tubercles are small, compressed, conical bodies, with a striated surface (fig. 1, *d*) ; several of these are found *in situ* on the plates of the test.

Affinities and differences.—This species most nearly resembles *C. clavigera*, König; it is distinguished from that species, according to Professor Forbes, by having “the ambulacral segments slightly broader in proportion to the inter-ambulacrals, and instead of their breadth being occupied by transverse series of about four granular tubercles, two of which are very small and inconspicuous, there are four, or, centrally, even six, nearly equal granular tubercles in each transverse row. The large spinigerous tubercles of the ambulacral plates are placed in areolæ, much smaller in proportion to the entire body than in *C. clavigera*, and the tubercles themselves are also smaller. The spaces between the rows of spinigerous tubercles are wider; they are thickly studded with nearly equal granules.”

The spines of *C. Bowerbankii* resemble those of *C. clavigera*; but the club-shaped head occupies the entire stem in the former, whereas in *C. clavigera* the club-shaped head is carried on the long stem. Compare Pl. II, fig. 1, with Pl. IV, fig. 1—3.

Locality and Stratigraphical Position.—This species has been found only in the Gray Chalk of Dover. The fine specimen I have figured is unique, and belongs to the cabinet of our kind friend Dr. Bowerbank, F.R.S.

History.—First figured by Prof. Forbes, in Dixon’s ‘Geology and Fossils of Sussex,’ who likewise established the species in that work. The same specimen has been kindly lent by Dr. Bowerbank to figure in this Monograph.

CIDARIS DISSIMILIS, *Forbes*. Pl. III, III *a*, figs. 1 and 2.

CIDARIS SCEPTRIFERA, *Forbes*, in Dixon’s Geology of Sussex, pl. xxv, fig. 3.

— DISSIMILIS, *Forbes*, in Morris’s Cat. of Brit. Fossils, 2nd ed., p. 74.

— — — *Woodward*. Mem. Geol. Survey, Decade v, expl. pl. v.

Test small, depressed, ambulacral areas narrow, flexuous, with six rows of small granules; inter-ambulacral plates, four to five in a column; areolæ circular, wide apart, surrounded by distinct secondary tubercles; principal tubercles prominent, bosses slightly crenulated, the inferior oral tubercles minute, the uppermost discal, rudimentary, and without areolæ; miliary granules large and prominent; spines slightly fusiform, surface covered with longitudinal lines of prickles.

Dimensions.—A. Transverse diameter eleven lines; height six and a half lines.

B. Transverse diameter, one and one fifth inches.

Description.—This urchin resembles *Cidaris sceptrifera* in its general characters, but was separated from that species by Professor Forbes in his MS. notes on this *Cidaris*.

The test is small and depressed at both poles; the ambulacral areas are narrow, with six rows of granules at the equator, diminishing to two rows at the discal and oral apertures (Pl. III *a*, fig. 2, *c*).

The inter-ambulacral areas are wide, and the plates large, from four to five in a column; the areolæ are circular and wide apart, the margins prominent, and surrounded by distinct secondary tubercles; the boss is prominent and slightly granulated; the tubercle is moderate in size and perforated; the tubercles near the peristome are small (fig. 2, *b*), and those nearest the apical disc rudimentary (fig. 2, *a*), and destitute of true areolæ (fig. 2, *c*).

The miliary zone is wide and zig-zag, and covered with large prominent granules (fig. 2 *c*), among which smaller granules are irregularly strewed.

I have given in fig. 1 *a* a drawing of the fine specimen of this species from the late Mr. Taylor's collection, now in the British Museum, and in fig. 2, *a*, *b*, a larger specimen from the cabinet of the Rev. T. Wiltshire, F.G.S.

The spines, according to Mr. S. P. Woodward, are of two kinds, "the largest above twenty-four lines in length, slightly swelling above the collar (two and a half lines in diameter), and then tapering to a fine point; collar short, striated finely; shaft granulated in lines; spines of the lower surface very slender, three- to six-sided, serrated at the angles; spines of the areolar circles two lines in length, compressed and striated."

Fig. 1, *b*, is a spine of *C. dissimilis* belonging to the British Museum.

Fig. 2, *d*, *e*, *f*, are spines from the collection of the Rev. T. Wiltshire.

Affinities and Differences.—This urchin so closely resembles *C. sceptrifera* that it was identified as such by Professor Forbes in Dixon's Geology of Sussex; in his manuscript notes on more perfect examples he had separated it under the name *C. dissimilis*. All the best specimens known to me I have figured in Pl. III *a*.

Locality and Stratigraphical Position.—This species was collected by Messrs. Clarke, Dixon, Taylor, and the Rev. T. Wiltshire, from the Gray Chalk at Dover; the finest of these specimens I have now figured for the first time. Fig. 1, *a*, *b*, belonged to the late Mr. Taylor's collection, and is now in the British Museum. Fig. 2, *a*, *b*, *f*, and figs. 3 to 5, belong to the Rev. T. Wiltshire's cabinet.

History.—This *Cidaris* was referred to *C. sceptrifera* by Professor Forbes in his description of that species in Dixon's Geology of Sussex. The subsequent discovery of more perfect specimens induced him to separate it from that form under the name of *C. dissimilis* in the MS. notes he left on the Cretaceous urchins.

D.—*Species from the White Chalk.*CIDARIS CLAVIGERA, *König*. Pl. IV, Pl. V, figs. 1—15.

	<i>De Luc</i> . Mém. sur un Échinide singulier Mém. Acad. Roy. des Sciences, t. ix, p. 467, pl. xii, 1763.
	<i>Andraë, J. G. R.</i> Briefe aus der Schweiz nach Hannover Geschr. in dem Jahr., 1763.
CIDARIS PAPILLATA, <i>var.</i>	<i>Leske</i> . Klein, Nat. disp. Echinoderm, p. 134, pl. xlvi, figs. 2 and 3.
— SPINIS CLAVICULATIS,	<i>Parkinson</i> . Organic Remains, t. iii, pl. iv, figs. 1 and 21, 1811.
— CLAVIGERA,	<i>König</i> , in Mantell's Geol. of Sussex, p. 194, pl. xvii, figs. 11 and 14, 1822.
— —	<i>König</i> . Icones Fossilium Sectiles, 1825.
— —	<i>Agassiz</i> . Prod. Mém. Soc. des Sc. Nat. de Neuchatel, t. i, p. 188, 1836.
— —	<i>Desmoulins</i> . Études sur les Échinides, p. 383, No. 34, 1837.
— PROPINQUA (pars)	<i>Desmoulins</i> . Ibid., p. 332, No. 22, 1837.
— CLAVIGERA,	<i>Geinitz</i> . Charakter der Schicht. und Petref. Kreidegebirges, p. 90, 1839.
— —	<i>Agassiz</i> . Catal. Syst. Foss., p. 10, 1840.
— —	<i>Hisinger</i> . Lethæa Suecica, pl. xxvi, figs. 5, 6, 1840.
— —	<i>Roemer</i> . Norddeutschen Kreidegebirges, p. 28, pl. vi, fig. 7, 1840.
— —	<i>Morris</i> . Cat. of Brit. Fossils., p. 49, 1843.
— —	<i>Agassiz et Desor</i> . Cat. rais. des Éch. Ann. Sc. Nat., 3e série, t. vi, fig. 327, 1846.
— —	<i>Reuss</i> . Versteinerungen der Böhmisches Kreideform., p. 57, pl. xx, figs. 17—20, 1846.
— —	<i>Graves</i> . Essai sur la top. Géog. du dép. de l'Oise, p. 692, 1847.
— —	<i>Bronn</i> . Index Palæontologicus, p. 298, 1848.
— —	<i>D'Orbigny</i> . Prodrome de Paléont., t. ii, p. 273, Ét. 22, No. 1246, 1850.
— —	<i>Sorignet</i> . Ours. de l'Eure, p. 1, 1850.
— —	<i>Forbes</i> , in Dixon, Geol. of Sussex, p. 338, pl. xxv, figs. 10, 11, 14, 18, 19, 20, 1852.
— —	<i>Quenstedt</i> . Handbuch der Petrefact., p. 575, pl. xlvi, fig. 46, 1852.
— —	<i>Forbes</i> , in Morris's Cat. of Brit. Fossils, 2nd ed., p. 74, 1855.
— —	<i>Desor</i> . Synopsis des Échinides Fossiles, p. 12, pl. vi, fig. 15, 1855.
— HEBERTI,	<i>Desor</i> . Ibid., p. 12, 1855.

CIDARIS CLAVIGERA,	<i>Pictet. Traité de Paléontol., 2nd ed., t. iv, p. 254, pl. xeviii, fig. 8, 1857.</i>
— —	<i>Cotteau. Paléontologie Française; Ter. Crétacé, t. vii, pl. 1069, 1070, 1071, p. 285, 1862.</i>
— —	<i>Dujardin et Hupé. Hist. Nat. des Zooph.; Échino- dermes, p. 480, 1862.</i>
— HEBERTI,	<i>Dujardin et Hupé. Ibid.</i>

Test circular, moderately inflated, of medium size, and nearly equally depressed at both poles. Ambulacral areas narrow, slightly flexed, with four rows of mammillated granules, the inner being smaller than the outer rows; inter-ambulacral areas wide, five very large tubercles in each row; areolæ deep, circular, and complete; margin surrounded by a circle of mammillated granules; tubercles large and imperforate, boss smooth; miliary zone wide, not depressed, furnished with large granules; peristome small, subpentagonal; apical disc large, subcircular; spines large, clavate, crowded with longitudinal, prickly ribs.

Dimensions.—Transverse diameter, one inch and three tenths; height, seven tenths of an inch.

Description.—The finest examples of this urchin extant are those now figured in Plates IV and V, the one belonging to my friend, Dr. J. S. Bowerbank, Pl. IV, the other to the British Museum, Pl. V, fig. 1; both these specimens were collected and developed by the late Mr. Taylor, and formed part of his collection of Cretaceous Echinodermata. Having had abundant materials at my disposal for the illustration of this species, I have endeavoured to give accurate figures of all parts of the test, as well as of the remarkable spines which armed it. An examination of the series I have figured will show how very much the spines, from different parts of the test, differ from each, and how cautious we ought to be in founding species of *Cidaris* on the spines alone.

The test is of medium size, circular, moderately inflated, and nearly equally depressed at both poles. The ambulacral areas are narrow, slightly flexed, and provided with four rows of granules; the external are the largest, and most regular, and are elevated on mammillated summits close to the border of the poriferous zones; the internal rows are composed of smaller granules, irregular in size, arrangement, and extent; towards the ends of the areas they diminish in size, and gradually disappear whilst the external rows are persistent throughout. A number of microscopic granules are irregularly scattered among the internal rows, and form a regular series at the angle of the external granules, on the border of the poriferous zones, and opposite each pair of holes.

The poriferous zones are narrow, depressed, and slightly flexed; the pores are large, round, and open, closely approximated to each other, and having small elevated granules on the septa (Pl. IV, fig. 1, *b*).

The inter-ambulacral areas are wide (Pl. IV, fig. 1; Pl. V, fig. 2, *a*, *b*), with five very large, prominent tubercles in each row; the areolas are narrow, deep, and circular, closely approximated near the peristome (Pl. V, fig. 2, *b*), and wide apart at the upper surface (Pl. V, fig. 2, *a*); the margin is surrounded by a circle of small mammillated granules (Pl. IV, fig. 1, *b*, *c*), a little larger than those which fill the miliary zone; the boss is small, and not prominent, and its summit quite smooth (Pl. IV, fig. *b*, *c*); the tubercle is very large and prominent (Pl. V, fig. 2; and Pl. IV, fig. 1, *b*, *c*); it forms three fourths of a sphere, and the surface is imperforate; the tubercle nearest the disc is sometimes surrounded by a rudimentary areola (Pl. IV, fig. 1, *a*; Pl. V, fig. 2, *a*), and placed wide apart from its penultimate fellow. The areolas at the under surface are so closely approximated that many of them are separated only by a single row of granules.

The apical disc (Pl. V, fig. 3) is wider in diameter than the peristome; the five ocular plates are large, with prominent orbits surrounded by a radiated structure; the ovarial plates have a rhomboidal figure, with the hole distant from the border; the anal plates are well preserved in the specimen fig. 3, in which sixteen plates remain *in situ*; the surface of all the elements of the disc is covered with small granules, set well apart from each other; fig. 3 shows the disc and its elements magnified two and a half times.

The jaws and teeth are *in situ* in the specimen belonging to the British Museum (Pl. V, fig. 1); the peristome is small (fig. 2, *b*); and more than half the opening was filled by a buccal membrane, on which two or three rows of scale-like plates are disposed in an imbricated manner. Pl. V, fig. 4, exhibits the buccal membrane and its plates magnified two and a half times.

The form of the spines varies in different parts of the test. In general they are claviform, more or less developed, with massive bodies, elongated necks, and small articular heads. The body and neck are ornamented with numerous longitudinal ridges; those on the massive body develop a denticulated, spiny margin, as seen in Pl. IV, fig. 5, and in other series of spines figured in this plate. The denticulated ridges are sometimes prominent and regular, unequal, oblique, and rudimentary; on the neck the ridges are in general smaller, longitudinal, and with finer denticulations on the margin; at the inferior third of the neck they diminish in size and disappear, and are replaced by granules, which likewise fill up all the intermediate space between the ridges, both on the neck and massive head. In some spines, with a large head and short neck, the weight of the spine is diminished by a series of canals, which extend into the head beneath the spaces between the ridges; the head is sometimes traversed by a large channel, opening at the summit, as in a specimen (Pl. V, fig. 6) from the Rev. T. Wiltshire's collection. The collar is very small, and finely striated; the milled ring is narrow, and separated from the collar by a depression; both ring and depression being finely milled; the acetabulum (fig. 2) is moderately deep, with a well-defined ring round the margin. In Plate IV, I have figured the finest specimen extant of this species; it belongs to my friend Dr. Bowerbank, and shews two tests with their spines attached *in situ*. This specimen exhibits the various

forms of the spines in different regions of the shell, and the series of figures between 3 and 23 shows some of the extreme shapes these appendages assume.

Affinities and Differences.—This urchin is readily distinguished from other species of the White Chalk by its small test, equally depressed at both poles, narrow areolæ, prominent imperforate tubercles, and large claviform spines, more or less elongated, and covered with spinous ridges. In this respect it resembles *C. Bowerbankii*, Forb., Pl. II, fig. 1, from which it is distinguished chiefly by the character of the spines, and the larger size of the inter-ambulacral tubercles. Compare Pl. II, fig. 1, *a*, with Pl. IV, fig. 1.

Locality and Stratigraphical Position.—This is the most common *Cidaris* in our White Chalk; it is found at Woolwich, Gravesend, Lewes, Brighton, and in the same formation in Wilts and Dorset. The specimens figured in Pls. IV and V were found near Woolwich, and developed by the late Mr. Taylor. The grand specimen figured in Pl. IV is in the possession of Dr. Bowerbank, that in Pl. V, showing the dental apparatus, peristomal plates, and apical disc, belongs to the British Museum.

It is very abundant in the Étage Sénonien of France, and found, according to M. Cotteau, at Dieppe, Fécamp, Tancarville (Seine-Inférieure); Falaise (Somme); Vernonnet, Giverny, Clachaloze, Petit-Andelys, Pinterville près Louviers, Hougue-marre, Sinneville (Eure); Notre-Dame-du-Thil, Mory la Herelle, le Mesnil-Saint-Fermin, Pouilly La-boissière (Oise); Maintenon, Château-Gaillard (Seine-et-Oise); le Mesnil-Saint-Thomas (la Poterie) (Eure-et-Loire).

History.—This urchin was first figured and described by De Luc in 1763, and afterwards by Leske and Parkinson; in 1822 by Mr. Koenig, in Mantell's 'Geology of Sussex,' who named it *C. clavigera*. The first accurate description of the test and spines was made by M. l'Abbé Sorignet, who pointed out the size and imperforation of its tubercles as important diagnostic characters. It has recently been well figured by M. Humbert for M. Cotteau in the 'Paléontologie Française;' and Mr. Bone has given most ample details from all the best English specimens that I am acquainted with.

CIDARIS SERRIFERA, Forbes, 1850. Pl. XI, fig. 1, *a, b, c, d, e, f, g, h*, fig. 6.

CIDARIS CLAVIGERA, Reuss. Versteinerungen der Böhmischen Kreidef., p. 57, pl. xx, fig. 21, 1845.

— *SERRIFERA*, Forbes, in Dixon's Geol. and Foss. of Sussex, p. 338, pl. xxiv, figs. 15—19, and pl. xxv, fig. 2, 1850.

— *PUNCTILLUM*, Sorignet. Oursins Foss. de l'Eure, p. 9, 1850.

— *SERRIFERA*, Forbes, in Morris's Cat. of Brit. Foss., 2nd ed., p. 75, 1854.

— *PUNCTILLUM*, Desor. Synopsis des Échinides Foss., p. 15, 1856.

— — Dujardin et Hupé, Zoophytes; Échinodermes, p. 481, 1862.

— *SERRIFERA*, Cotteau. Paléontologie Française; Ter. Cret.; Échinides, tom. ii, p. 293, pl. 1071, figs. 5—15, 1863.

Test small, circular, convex above, flat below, poriferous zones narrow, depressed, slightly flexed, pores oval, approximated, separated by a small granule; ambulacral areas sinuous and depressed in the middle, with from six to eight rows of small, round granules; inter-ambulacral areas wide and inflated above, with four to five small perforated tubercles in each row, placed wide apart, with a miliary zone between them; spines long, slender, cylindrical, covered with longitudinal, compressed, spiny ribs, having a wide valley and granulated surface between them.

Dimensions.—Transverse diameter, one inch and one sixth; height, six tenths of an inch.

Description.—This beautiful urchin was distinguished by Professor Forbes from *C. clavigera*, for which it had been mistaken by Reuss, and was first figured in Dixon's 'Geology of Sussex'; it forms a well-marked species, which is very rare in our Cretaceous rocks. The test is small, and circular; inflated at the equator and upper surface, and flattened below; the poriferous zones are slightly flexed, narrow, and depressed; the pores are small, oval, and approximated; there is a granule between them on the septum; and an oblong transverse ridge between each pair. The ambulacral areas are narrow, and slightly undulated; the plates incline gently towards the median suture, and are provided with from four to six rows of small, close-set granules, of which the external rows are the largest, and raised on mammillated eminences; the smaller and shorter middle rows disappear near the disc and the peristome, where there are only the two external rows of mammillated granules; there are from fifteen to seventeen files of granules opposite one of the large plates. The wide inter-ambulacral areas are slightly inflated above and near the equator, and have from four to five deep plates in each series; the areolæ are small, and gradually increase in diameter from the peristome to the uppermost tubercle; on the uppermost plate of each alternate series the tubercle is nearly obsolete; the border of the areola is a little elevated, and surrounded by a circle of small, spaced-out, mammillated granules (fig. 1, *d*), a little larger than those which fill the miliary zone; the boss is small, the summit smooth, and the tubercle perforated in all the specimens I have seen; the inter-tubercular spaces and central miliary zone are filled with a fine, uniform, close-set granulation; on the upper part of the shell the tubercles nearest the disc are small, imperfectly developed, and surrounded by the merest trace of an areola; the sutures of the plates are depressed and conspicuous; the peristome (fig. 1, *b*) is small, circular or subpentagonal; the discal opening is larger than the peristome, and sub-pentagonal; a portion of the disc, concealed in the specimen (fig. 1, *a*), exhibits a finely granulated surface.

In a fossil I collected twenty years ago at Lewes, in Sussex, many of the spines are preserved *in situ* on the fragment of the test (fig. 1, *e, f, g*); they are long, slender, and cylindrical, having seven or eight compressed ridges, with a denticulated border; the

valleys between the ridges are concave, and the surface of these is very finely granulated; the neck is long and smooth (fig. 1, *f*, and fig. 2); it is bounded by a fine line, and beyond this is a narrow circle with microscopic lines conducting to a milled ring, which is prominent and finely sculptured (fig. 1, *f*, and fig. 2); the head is small, and the rim of the acetabulum striated; the small secondary spines are flat and conical (fig. 1, *h*), and have the surface ornamented with fine longitudinal lines.

Affinities and Differences.—This species is allied to *Cidaris vesiculosa*, Goldfuss, but distinguished from that form by having the test more regularly convex, the plates of the inter-ambulacra less inflated, and fewer tubercles in each series. The spines of the two species are likewise different. It resembles *Cidaris scepterifera*, Mantell, but has smaller areolas, less prominent scrobicular circles, fewer tubercles in each column of plates; and the spines are very distinct (compare for example Pl. VII, fig. 1, with Pl. XI, fig. 1). According to Professor Forbes, it differs from *Cidaris subvesiculosa*, d'Orbigny, in having the inter-ambulacra composed of large plates with impressed areolæ around the spiniferous tubercles, four to six in the perpendicular row. Tubercles larger in proportion to the areolæ than in the last species. Superior plates with indistinct tubercles, but not so obsolete as in *C. subvesiculosa*. Granulated portion of the plates finely grained; the sutures are not impressed; the avenues of pores, of which about fourteen correspond to the largest plate, are broader in proportion to the ambulacra. There is a tubercle between each pore, and an oblong transverse ridge between each pair.

Locality and Stratigraphical Position.—I collected, about twenty years ago, a specimen of this urchin with the spines attached to the test, in the Upper Chalk, at Lewes, in Sussex; the example of this species figured in Dixon's work was obtained from the same locality. The fine fossil which I have figured in Pl. XI, fig. 1, was kindly communicated for this Monograph by Henry Willett, Esq., F.G.S., Brighton. This specimen appears to be the original fossil which was figured before by Sowerby in Dixon's 'Geology of Sussex;' if so, it formed the subject of Professor Forbes' observations.

In France this urchin is very rare; it was found in the Étage Sénonien at Civières, Giverny (Eure); Royan (Charente-Inférieure).

History.—This species was first well figured as *Cidaris serrifera* by Professor Forbes in Dixon's 'Geology of Sussex' in 1850. The same year M. l'Abbé Sorignet described it under the name *C. punctillum* in his work on the Fossil Urchins of the Department of the Eure; as this account was not accompanied by a figure, I have retained the name of the figured specimen. In 1845, Prof. Reuss figured this *Cidaris* in his fine work on the Fossils of the Bohemian Chalk-formation, and erroneously referred it to *Cidaris clavigera*, König, from which it differs in many important details both in the structure of the test and spines.

CIDARIS SCEPTRIFERA, *Mantell.* Pl. V, figs. 16, 17; Pl. VI; Pl. VII, figs. 1, 2; Pl. VII a, figs. 1, 3.

CIDARIS CUCUMERINA,	<i>Parkinson.</i> Organic Remains, vol. iii, pl. iv, fig. 2, 1811.
— SCEPTRIFERA,	<i>Mantell.</i> Geol. of Sussex, p. 194, pl. xvii, fig. 12 (spine), 1822.
— —	<i>Agassiz.</i> Catal. Syst. Ectyp. Foss., p. 10, 1840.
— —	<i>Rœmer.</i> Norddeutschen Kreidegebirge, p. 28, 1840.
— CRETOSA,	<i>Morris.</i> Catalogue of Brit. Foss., p. 49, 1843.
— —	<i>Agassiz et Desor.</i> Catal. rais. des Échinides; Ann. Sc. Nat., 3e sér., t. vi, p. 328, 1846.
— VESICULOSA,	<i>Reuss,</i> pars. Versteinerungen der Böhmisches Kreideformation, p. 57, pl. xx, fig. 15, 1846.
— SCEPTRIFERA,	<i>Graves.</i> Essai sur la Topogr. Géol. du Dep. de l'Oise, p. 688, 1847.
— —	<i>Bronn.</i> Index Palæontologicus, p. 298, 1848.
— —	<i>d'Orbigny.</i> Prod. de Pal. Strat., t. ii, p. 274, 1850
— —	<i>Sorignet.</i> Ours. de l'Eure, p. 6, 1850.
— —	<i>Forbes,</i> in Dixon, Geol. of Sussex, p. 338, pl. xxv, figs. 3—7, 1850.
— —	<i>Forbes,</i> in Morris, Catal. of Brit. Foss., 2nd edit., p. 74, 1854.
— —	<i>Desor.</i> Synopsis des Échinides Foss., p. 13, pl. v, fig. 28, 1855.
— —	<i>Woodward.</i> Mem. of the Geol. Survey, Dec. v, expl. to pl. v, fig. 12, 1856.
— —	<i>Leymerie et Raulin.</i> Stat. Géol. du Départ. de l'Yonne, pp. 510—620, 1858.
— —	<i>Coquand.</i> Synops. des Foss. Form. Crét. du Sud-Ouest de la France; Bull. Soc. Géol., 2e sér., t. xvi, p. 1013, 1860.
— —	<i>Cotteau et Triger.</i> Éch. du Dép. de la Sarthe, p. 253, pl. xlii, figs. 1—8, 1860.
— —	<i>Cotteau.</i> Paléont. Française, p. 251, pl. 1056-57-58, 1863.
— —	<i>Hupé.</i> Hist. Nat. Zooph.; Echinodermes, p. 480, 1862.

Test moderately large and inflated; more or less elevated, and nearly equally flattened at both poles; ambulacral areas narrow, depressed, flexuous, with six rows of granules in the middle, diminishing to four rows above and below; poriferous zones narrow, winding, and depressed; inter-ambulacral areas wide; plates very large, five to six in a column; areolæ deep, circular, with an elevated, prominent, scrobicular margin, encircled by a series of small granules, scarcely larger than those of the miliary zone; boss not prominent, summit feebly crenulated in young, and smooth in old shells; tubercle moderate in size and perforated; proximal discal plate in each column with a rudimentary tubercle, and an elongated obsolete areola; miliary zone filled with small, equal-sized granules, much

depressed along the line of all the sutures; apical disc wide; ovarian plates thick, large; ocular plates heart-shaped; spines long, cylindrical, fusiform, enlarged at the inferior third, and tapering gently to the summit; surface covered with regular, longitudinal rows of spiny, projecting granules, the intervening space being finely shagreened.

Dimensions.—Height, one inch and four tenths; transverse diameter, one inch and three tenths.

Description.—A very good figure of a fragment of the test and spines of this urchin was given in Parkinson's 'Organic Remains,'¹ pl. iv, fig. 2, and a fair drawing of the upper surface of the shell in pl. i, fig. 11; both were, unfortunately, unaccompanied by any description.

This beautiful species attains a considerable size; the test is circular, and nearly equally depressed at both poles (Pl. VI, fig. 1, *c*); the ambulacral areas are very narrow and flexuous, with six rows of granules at the equator, diminishing to four rows at both poles; the external rows are the largest and most persistent, and the internal rows are found only in the wide portion of the area; in large shells there are many smaller granules, dispersed among the regular rows (Pl. VI, fig. 1, *d*); the poriferous zones are very narrow and depressed, following the flexures of the areas; the pores are small, round, closely approximated, and disposed obliquely, having a minute granule on the septum, and there are twenty-four to twenty-six pores opposite one of the larger plates (fig. 1, *d*).

The inter-ambulacral areas are very wide, and there are from four to five large plates in a column; in consequence of the prominence of the scrobicular circle, each plate is thickened at the middle, and the lines of sutures between the plates are all very much defined, in consequence of the plate sloping away from the scrobicular circle to the suture; the areolas are wide and circular, and surrounded by a thick, prominent border (fig. 1, *d*), encircled by a series of seventeen granules, each raised on a distinct, shield-like, mammillated plate; the boss is not prominent, its summit is feebly crenulated in young shells, and smooth in old ones (Pl. VI, fig. 1); the tubercle is moderately large and perforated; the plates near the peristome (Pl. VI, fig. 1, *b*) are disproportionately small compared with those of the equator (fig. 1, *c*, *d*); and the last plate of each column in old shells (fig. 1, *a*, *e*, *f*) has an elongated form, with a rudimentary tubercle, and curious elongated furrow, representing an obsolete areola. Mr. Bone has given most accurate drawings of this remarkable plate from the fine specimen in the British Museum; the singular star-like structure which these plates form on the upper surface of the test, surrounding the large apical disc, forms a remarkable character of this species, fig. 1, *a*.

The miliary zone is narrow, zig-zag, depressed in the middle, and provided with fine, close-set, nearly equal-sized granules, very much smaller than those surrounding the areolas.

¹ 'Organic Remains,' vol. iii, pl. iv, fig. 2.

The apical disc is very wide (Pl. VI, fig. 1, *a*); the ovarial plates are large, thick, irregular pentagons (fig. 1, *g*), and the ocular plates are heart-shaped; the surface of both series is covered with a close-set granulation; the ovarial and ocular holes are very conspicuous in this species; within the ovarials the external circle of anal plates are found *in situ* (fig. 1, *a, g, h*).

The mouth-opening (Pl. VI, fig. 1, *b*) is nearly circular, and smaller than the anal opening; the jaws are strong and powerful, as seen in Pl. VII, fig. 1, *a, b*.

The spines are long, cylindrical, and fusiform, thickest at the lower third, and tapering gently from thence to the point (Pl. VI, figs. 2—5); they are covered with small, spiny, equal-sized granules, the points of which are directed outwards; they are arranged in regular, longitudinal rows, with a valley between them; the prickles diminish in size near the collar, and at the summit of many of the large spines the rows of granules form a stellate termination (Pl. VI, fig. 3, *a, b, c*); the valleys are covered with a finely corrugated surface, the eminences forming microscopic longitudinal lines. The neck is very short and delicately striated (fig. 4, *b*), the head moderately large, and the milled ring not prominent; the rim of the acetabulum is feebly crenulated, and its concavity contains a deep depression for the round articular ligament; the length of the large spines, figured in Pl. VI, figs. 3 and 4, contained in the British Museum, is two inches and nine tenths. One figured by M. Cotteau, from the French Chalk, is three inches long.

Affinities and Differences.—*Cidaris sceptrifera* so closely resembles, in many points of structure, *Cidaris subvesiculosa*, d'Orbigny, that by some they have been thought to be varieties of one species; the facts on which their distinctness may be maintained are the following: *Cidaris subvesiculosa* has a more elevated test, with a greater number of plates in a column, the areolas are smaller and less depressed, the circle of scrobicular granules is less prominent, and the obsolete tubercles on the upper plates of the columns are smaller, more numerous, and differently formed; the granules covering the miliary zone are smaller, and more regularly disposed in rows radiating from the areola. The grand distinction is found in the spines, which are much smaller in *C. sceptrifera*, tapering, but not fusiform, and covered with longitudinal serrated lines. Compare the different excellent figures of *Cidaris subvesiculosa*, d'Orbigny, in Pl. VIII, with the admirable drawings of *Cidaris sceptrifera*, Mantell, in Pl. VI and VII.

Locality and Stratigraphical Position.—*Cidaris sceptrifera* is found in the Upper White Chalk of Kent, Sussex, and Wilts. The truly magnificent specimens figured in Pl. VI, fig. 1, and Pl. VIIa, fig. 1, belong to the British Museum; the specimens figured in Pl. VI, fig. 2, and Pl. VII, fig. 1, belong to the Museum of the Royal School of Mines. I need scarcely add they are the finest known.

In France, M. Cotteau enumerates the following localities in which this species is found: Dieppe (Seine-Inférieure); la Faloise (Somme); Vernonnet, Giverny, Civières,

Petit-Andelys, Pinterville près Louviers, Senneville, Evreux (Eure); Notre-Dame-du-Thil Frocourt, les Blamonts, Therdonne, Pouilly, Reims, Broyes, la Herelle, le Mesnil-Saint-Firmin, Mory (Oise); Chalons-sur-Marne (Marne); la Ferté-Loupière (Yonne); Clachaloze, Maintenon (Seine-et-Oise); Marçon (Sarthe); Villedieu, Limeray (Loir-et-Cher); le Ménil-Saint-Thomas (la Poterie) (Eure-et-Loir); Aubeterre (Charente); Talmont, Saint-Georges, Royan (Charente Inférieure). Étage Sénonien. Saint-Paterne (Sarthe); Étage Turonien, zone *Terebratella Bourgeoisii*.

History.—First figured by Parkinson in 1811; the test and spines are both well drawn, so that no doubt as to the species intended can exist, although no description of the urchin was given. In 1822, Mantell figured one of the spines, and gave it the name which it still retains. This species was not indicated in France until 1840, when it was entered in M. Agassiz' *Catalogus systematicus*; since then its test and spines have been found in the localities enumerated above.

CIDARIS SUBVESICULOSA, *d'Orbigny*. Pl. VIII, figs. 2, 4, 5, 6.

CIDARES PAPILLATÆ,	<i>Parkinson</i> . Organic Remains, vol. iii, p. 39, pl. iv, fig. 3, 1811.
CIDARIS CRETOSA,	<i>Mantell</i> . Geol. of Sussex, Trans. Geol. Soc., vol. iii, p. 205, 1835.
— PAPILLATA,	<i>Mantell</i> . Geol. of Sussex, p. 194, pl. xvii, fig. 13, 1822.
— CRETOSA,	<i>Morris</i> . Catal. of British Fossils, p. 50, 1843.
— VESICULOSA,	<i>Morris</i> . Ibid., p. 51, 1843.
— PAPILLATA,	<i>Reuss</i> . Die Versteinerungen der Böhmischen Kreideformation, p. 57, pl. xx, fig. 22, 1846.
— CRETOSA,	<i>Graves</i> . Essai sur la Topog. Géog. du Département de l'Oise, p. 688, 1847.
— —	<i>Bronn</i> . Index Palæontologicus, p. 298, 1848.
— SUBVESICULOSA,	<i>d'Orbigny</i> . Prod. de Paléontol. Strat., t. ii, p. 274, 1850.
— OVATA,	<i>Sorignet</i> . Ours. Foss. de l'Eure, p. 9, 1850.
— AMBIGUA,	<i>Sorignet</i> . Ibid., p. 10, 1850.
— VESICULOSA,	<i>Forbes</i> , in Dixon's Geol. of Sussex, p. 338, pl. xxv, figs. 1—4, 1850.
— —	<i>Quenstedt</i> . Handbuch der Petrefactenkunde, p. 375, pl. xlviii, fig. 49, 1854.
— —	<i>Forbes</i> , in Morris's Catalogue of British Fossils, 2nd ed., p. 75, 1854.
— SUBVESICULOSA,	<i>Desor</i> . Synopsis des Échinides Foss., p. 13, pl. v, fig. 27, 1855.
— GRANULO-STRIATA,	<i>Desor</i> . Ibid., p. 14, pl. v, fig. 26, 1855.
— OVATA,	<i>Desor</i> . Ibid., p. 14.
— AMBIGUA,	<i>Desor</i> . Ibid., p. 15.

- CIDARIS SUBVESICULOSA, *Coquand*. Bull. Soc. Géol. de France, 2e serie, tom. xvi, p. 1913, 1860.
- — — *Cotteau et Triger*. Échin. du dép. de la Sarthe, p. 250, pl. xli, figs. 1—9, 1860.
- — — *Cotteau*. Paléontologie Française, Ter. Crétacé, tome vi, p. 257, Pls. 1059—1061, 1863.

Test large, circular, inflated, nearly equally depressed at both poles; ambulacral areas slightly flexed, wide, with six rows of nearly equal-sized granules at the equator, diminishing to four and two rows at the poles, the external series being the largest and most persistent; poriferous zones narrow, depressed, and composed of simple oval pores, separated from each other by an elevation of the septum; inter-ambulacral areas wide, six or seven large plates in a column; the three equatorial plates with large areolæ, those near the peristome small, and the two upper plates near the disc with small rudimentary tubercles; areolæ circular, depressed, surrounded by a ring of mammallated granules, boss flat, with a smooth summit, tubercle moderate and perforated; miliary zone wide, filled with fine close-set homogeneous granules, disposed in very regular horizontal lines, radiating from the scrobicular circle to the border of the plates; peristome small and pentagonal; apical disc large, ovarian plates wide, narrow, and perforated at a distance from the border; ocular plates heart-shaped, with marginal orbits. Two consecutive series of cuboidal anal plates arranged within the pentagonal area formed by the ovarials; vent small and sub-central.

Spines slender, elongated, and cylindrical; surface covered with longitudinal elevations, having a fine serrated or spinous border gradually becoming attenuated towards the base; neck short, with longitudinal lines; milled ring prominent, articular surface without crenulations.

Dimensions.—Specimen fig. 5—height, one inch and one tenth; transverse diameter, one inch and seven tenths.

Description.—This urchin has been mistaken for *Cidaris vesiculosa*, Goldf., from which it differs, however, in many important characters; these have already been indicated in the description of that species (p. 41). The test is in general of moderate size, and nearly equally depressed at both poles; the ambulacral areas are slightly flexed, with six rows of granules at the equator; the external rows have larger mammillated granules than the inner rows, which gradually disappear as the area becomes narrower near the peristome and disc; the poriferous zones are narrow, depressed, and sub-flexuous; the pores are oval, and oblique as they approach the disc, and the septa have small elevated granules between the holes. The inter-ambulacral areas are large, the plates wide and deep, six or seven in a column (Pl. VIII, figs. 4, 5), the areolas are circular and moderately depressed; they are widely spaced out at the upper surface, and placed closer together at the infra-

marginal region and near the peristome; the margin is surrounded by a complete circle of large mammillated granules raised on shield-like plates. On the two uppermost plates of each column the areolæ are very narrow, or altogether obsolete (fig. 4, *a*). The boss has a flat smooth summit (fig. 1, *c*), and the large tubercle is deeply perforated (fig. 1, *c* and *d*). The miliary zone is very wide at the equator, and becomes narrower near the peristome and the disc. It is more or less depressed in the middle, along the line of the sutures, and covered with fine homogeneous granules set closely together; the granules are arranged in regular horizontal lines (fig. 1, *c*, *d*, *e*), which radiate from the circumference of the areolæ to the border of the plate.

The apical disc is large and pentagonal (fig. 4, *a*, *b*), and well preserved *in situ* in the fine specimen, fig. 4, *a*. The five large ovarian plates have an irregular rhomboidal form, with the ductal holes near the border; the oculars are heart-shaped, and have marginal orbits; the anal plates form a double series within the discal circle, and the vent (fig. 4, *b*) is a small excentral aperture with a third series of small plates on its anterior part only. All the elements of the disc are closely covered with the same style of granules that fill the miliary zone.

The peristome, smaller than the discal opening, is of a pentagonal form; in none of our specimens are the dental pyramids preserved.

The spines are long, slender, cylindrical, with longitudinal ribs having a spinous border (fig. 2, *a*, *b*); the valleys between the elevations have a finely chagreened surface; the neck is short and striated, the head moderately large, and the milled ring prominent (fig. 2, *c*). The acetabulum has a smooth rim. One spine must have measured $2\frac{3}{4}$ inches in length. The large mammillated granules surrounding the areolæ supported small, flat, triangular spines (fig. 6), having their surface ornamented with longitudinal microscopic lines, and articulated to the tubercle by a semicircular depression at the base. I have figured one of these scrobicular spines at fig. 6, where the line shows the natural size, and the figure is enlarged four diameters.

Affinities and differences.—This species has long been considered to be the *Cidaris vesiculosa*, Goldf., but is distinguished from that urchin in having the ambulacra less flexed, a greater number of plates in the inter-ambulacral columns, the upper tubercles of both series rudimentary, and in having the granules in the miliary zone arranged in horizontal rows. *Cidaris vesiculosa*, Goldf., has a smaller test, the ambulacra much more flexed, the plates in a column fewer, the tubercles consequently wider apart, the upper tubercles largely developed, and the granules in the miliary zone not arranged in horizontal rows. The spines in *C. subvesiculosa* are long, slender, and tapering; those in *C. vesiculosa* are shorter and thicker. This urchin so closely resembles *C. perlata*, Sorignet, and *C. Vendocinensis*, Ag., that they appear to me to be only varieties of *C. subvesiculosa*, d'Orbig.; the spines of the latter likewise closely resemble those attributed to *C. serrata*, Desor. It is possible that if a collection of good type-specimens of these different reputed

species were compared with each other, they would be found to be only so many cognate varieties of one form.

Locality and Stratigraphical position.—This species is found in the Upper Chalk of Kent, Sussex, and Wilts.

In France M. Cotteau gives the following localities in which it is very common in the Étages Turonien et Sénonien : Bolbec (Seine-Inférieure) ; Houguemarre, Vernonnet, Petit-Andelys (Eure) ; Notre-Dame-du-Thil, Tartigny (Oise) ; la Faloise (Somme) ; Saint-Fraimbault, Marçon, les Menus (Sarthe) ; Villedieu, Villiers (Loir-et-Cher) ; Semblancay, Limeray (Indre-et-Loire) ; Briolay (Maine-et-Loire) ; Barbezieux, Aubeterre, Lavalette, Salles (Charente) ; Royan, Saint-Georges Talmont, Saintes, Cognac (Charente-Inférieure) ; Périgueux, Trétissac, Neuvic (Dordogne) ; Bugarach, Soulatge (Aude).

History.—This urchin was first figured by Parkinson in 1811. The test and spines are sufficiently well drawn, in the absence of a description, to enable us to identify the species. In 1822 Mantell described, under the name *C. cretosa*, a *Cidaris* represented by Parkinson ('Organic Remains,' Vol. III, Pl. I, fig. 11), and united to fig. 3, Pl. IV, of the same work, which served as the type of *C. subvesiculosa*. Professor Forbes identified this species with the *C. vesiculosa*, Goldf., and figured it under that name in Dixon's 'Geology of Sussex.' In 1850 M. d'Orbigny, in his 'Prodrome de Paléontologie,' separated it from that form under the name *subvesiculosa*, which has been adopted by MM. Desor, Cotteau, and other authors.

CIDARIS MERCEYI, *Cotteau*. Pl. VIII, figs. 1, 2, 3.

CIDARIS MERCEYI, *Cotteau*. Paléont. Française, Ter. Crétacé Échinodermes, tom. vii, p. 281, pl. 1068, 1862.

Test large, circular, and elevated above, inflated and depressed below ; ambulacra narrow, depressed, and slightly flexed ; two rows of small regular mammillated granules on the external border, and four rows of smaller, irregular granules on the central portion of the area ; poriferous zones narrow, flexed, composed of round pores in oblique pairs ; inter-ambulacra wide, six or seven large plates in a column ; tubercles well developed at the base and equator, but small and obsolete on the upper surface ; areolæ circular, depressed, margin surmounted by a circle of regular mammillated granules.

Dimensions.—Height, two inches ; transverse diameter, two and a half inches.

Description.—This remarkable urchin, which appears to be an elevated variety of *Cidaris subvesiculosa*, has been described by M. Cotteau as a distinct species under the

name *C. Merceyi*. The test is large and circular, elevated at the upper surface, inflated at the equator, and flat at the base (fig. 1, *a*, *b*). The ambulacral areas are narrow and slightly flexed, much depressed at the medium suture, and furnished at the widest part with six rows of granules. The two marginal rows have larger granules, very regular in size and arrangement, and raised on small plates (fig. 1, *c*); the four inner zones are much smaller and less regular (fig. 1, *c*); the poriferous zones are narrow, deeply sunk, and slightly bent; the small round pores are disposed in oblique pairs, of which there are twenty-one, opposite one large equatorial plate (fig. 1, *c*).

The inter-ambulacral areas are wide and largely developed; there are from six to seven plates in each column, of which the four or five lower plates have large areolæ, with moderately sized tubercles; the two uppermost plates are destitute of areolæ, and have small rudimentary tubercles (fig. 1, *a* and *b*). The areolæ at the base and equator are narrow and deeply depressed, well spaced out from each other at the equator, and set closer together at the base. The scrobicular margin of one of the equatorial plates is surrounded by a circle of eighteen regular mammillated granules, larger than those filling the miliary zone (fig. 1, *c*); the boss is prominent, the summit smooth, and the tubercle moderately large and widely perforated (fig. 1, *d*). Above the equator the two or three upper tubercles entirely change their character, the areolæ become extremely narrow or disappear (fig. 1, *b*), and the tubercle becomes a mere rudiment in the midst of the miliary granulation. The plate of this series nearest the equator, the third from the discal end, supports a very narrow areola (fig. 1, *e*) with a small tubercle, and on the two uppermost plates the tubercles are mere warty rudiments surrounded by granules.

The inter-ambulacral plates are large, convex, and inflated (fig. 1, *c*, *d*, *e*) towards the middle, and slope gently towards the sutures, which are very well marked in this species.

The miliary zone is wide and well developed, depressed in the middle and between the plates; the granules are fine, abundant, and homogeneous, and arranged in regular lines that radiate horizontally from the areolæ to the borders of the plate (fig. 1, *c*, *d*, *e*), resembling in this respect *C. subvesiculosa*.

The mouth-opening is small, and the peristome pentagonal; the upper surface of the test is fractured, and the disc absent. M. Cotteau, who has figured a very complete specimen of this *Cidaris*, says that the periproct is pentagonal and star-shaped, and the disc solid and inflated, and larger than the peristome; the ovarian plates are thick and angular, their internal surface smooth and marked by three facettes for articulation with the external row of anal plates; the ocular plates are small, subpentagonal, deeper than wide, and not notched at the summit of the ambulacra.

The spines have not been found in relation with the test.

Affinities and differences.—This species resembles in so many important particulars the preceding species, that I hitherto considered it to be a conoidal variety of that form.

M. Cotteau says this is one of the most curious species of *Cidaris*. Its form is in

general inflated and sub-conical, its superior inter-ambulacral plates are entirely deprived of tubercles, the structure of its periproct and apical disc impart a peculiar physiognomy to it, and clearly distinguish it from its congeners. It is distinguished from *C. sub-vesiculosa* by its greater size, its inflated sub-conoidal form, its straighter ambulacra, and smaller and less regular granules. Its inter-ambulacral plates are more numerous, and the three uppermost plates in each column are entirely deprived of tubercles in the specimen figured by M. Cotteau, and they are small and rudimentary in the urchin figured in our Pl. VIII, fig. 2.

Locality and Stratigraphical position.—Collected from the White Chalk, where it is very rare. The fine specimen figured by Mr. Bone belongs to Dr. Bowerbank's collection. That figured by M. Humbert for M. Cotteau was collected at La Faloise près Breteuil (Somme); in the Étage Sénonien, where it is very rare. It belongs to M. Tombeck's collection.

CIDARIS PERORNATA, *Forbes*, 1850. Pl. VII a, fig. 2.

- CIDARIS PERORNATA, *Forbes*, in Dixon's Geol. of Sussex, p. 339, pl. xxv, fig. 8.
1850.
- LONGISPINOSA, *Sorignet*. Ours. Foss. de l'Eure, p. 19, 1850.
 - SARTHACENSIS, *d'Orbigny*. Prod. de Pal. Strat., t. ii, p. 274, 1850.
 - PERORNATA, *Forbes*, in Morris's Catal. of Brit. Fossils, 2nd edit., p. 74, 1854.
 - — *Cotteau*. Paléontologie Française, t. vii, p. 274, pl. 1065, figs. 3—14, 1862.

Test elevated, melon-shaped. Ambulacra nearly straight, narrow, depressed. Six rows of small granules, the marginal the largest and most regular, the inner small, with intermediate smaller ones. Inter-ambulacra wide, seven or eight large plates in each column; areolæ wide, circular, with a marginal circle of very small granules; boss smooth or slightly crenulated; tubercles small and perforate; sutures well marked, depressed. Spines long, cylindrical, several-ridged; ridges irregular towards the base, and serrated, the interstices granulated.

Dimensions.—Height, one inch and eight tenths; transverse diameter, two inches.

Description.—The test of this fine urchin is high and melon-shaped, and reminds me of *C. maximus*, from the Coral-rag of Germany. The ambulacral areas are narrow,

nearly straight, and provided with six rows of small granules; the marginal series are the largest, the inner ones are small, and between them are some still smaller granulets scattered about the area. The poriferous zones are only gently waved, the holes round, and placed transversely; there are fifteen pairs opposite each of the equatorial plates. The inter-ambulacral areas are very regularly formed; the plates, about eight in each column, are large and uniform; the areolæ are wide and circular, and occupy the entire depth of the plate; the margin is surrounded by a circle of very small mammillated granules, about twenty-one in number, and well spaced out from each other; the boss is not prominent, and only some of the summits are feebly crenulated, whilst the others are smooth. The tubercle is small, and deeply perforated (fig. 2, *a*, *b*). The miliary zone is wide, and depressed in the middle; the granules are fine, homogeneous, and nearly equal-sized, and arranged in regular horizontal rows, which follow the angles of the median sutures. As the areolæ occupy the centre of the plates, there is a considerable granular space between the ambulacral side of the areolæ and the poriferous zones. The sutures are all very distinctly marked, and the median inter-ambulacral is much depressed. The peristome is sub-pentagonal and large. The spines are long, cylindrical, and sub-acuminated at the summit (fig. 4, *a*). The stems are provided with long, narrow spines, projecting at intervals from many regular, longitudinal ridges, and having the interstices finely granulated (fig. 4, *c*). For the most part these spines are equally and uniformly disposed; sometimes, however, they lose their homogeneity, and vary in their height and in preserving a longitudinal disposition. The valleys between the ridges on the stem are throughout covered with fine, delicate, microscopic, sub-granular, longitudinal striæ, which are only visible by the aid of a lens (fig. 4, *c*). The neck is without ridges and spines; the collar is long and finely striated, and separated from the stem by a distinct line (fig. 4, *b*). The head is large, the milled ring prominent, with thicker striæ than those on the collar, and the rim of the acetabulum is smooth (fig. 4, *b*).

Affinities and differences.—The melon-shaped test, very regular inter-ambulacral areas, areolæ and tubercles gradually increasing from the base to the upper surface, added to the long, slender spines, with prickly ridges, serve to distinguish this species from its congeners of the White Chalk. The spines resemble those attributed to *C. spinigera*, Cott., of the Neocomian stage, from the middle of France, but they manifest differences which are sufficiently distinctive of each. In *C. perornata* the spines arise from ridges at regular intervals, which are absent in *C. spinigera*.

Locality and Stratigraphical position.—This species was collected from the White Chalk of Kent and Sussex. The specimens figured are from the cabinets of Dr. Bowerbank and Rev. T. Wiltshire.

The foreign localities of this urchin are, according to M. Cotteau, Vernonnet, Giverney, Pinterville, Houguemarre (Eure), Épagny (Somme), Tartigny (Oise), La Flèche, (Sarthe); where the spines are common in the Étage Sénonien.

History.—The late Frederick Dixon, Esq., F.G.S., and Professor Forbes, first figured, in 1850, the test and spines of this species from the White Chalk of Sussex, and the latter described it as a new species under the name *C. perornata*. M. l'Abbé Sornnet described the spines which he collected in the department of the Eure under the name *C. longispinosa*, and Professor d'Orbigny those found in the Sarthe as *C. Sarthacensis*. As Professor Forbes first figured and described the urchin, and the other authors only described it, the name of the figured specimen is for this reason retained.

CIDARIS HIRUDO, *Sornnet*, 1850. Pl. X, figs. 1—5 ; Pl. IX.

CIDARIS HIRUDO,	<i>Sornnet</i> . Ours. Foss. de l'Eure, p. 17, 1850.
— SCEPTRIFERA,	<i>Forbes</i> , in Dixon's Geol. of Sussex, p. 338, pl. xxv, figs. 32 and 33,
— —	var. SPINIS TRUNCATIS. 1850.
— SULCATA,	<i>Forbes</i> , in Morris's Catal. of Brit. Fossils, 2nd edit., p. 75, 1854.
— —	<i>Woodward</i> . Mem. of Geol. Surv., Decade v, explanation of pl. v, p. 3, 1856.
— HIRUDO,	<i>Cotteau</i> . Paléontologie Française, tom. vii, p. 244, pl. 1054, figs. 6—16.

Test, in general, of moderate size, sometimes large, slightly depressed equally at both poles; ambulacral areas narrow, flexed, with six rows of granules at the equator, diminishing to two at the apertures; in the two external rows the granules are larger and mammillated, in the inner rows they are very regularly disposed, but smaller and unequal; poriferous zones very narrow, depressed, and flexed, and formed of small round pores, the intervening septum having a slight divisional elevation; inter-ambulacral areas wide; columns with five or six large plates; areola moderate, depressed, margin elevated, and surrounded by a circle of mammillated granules, well spaced out apart; boss with a smooth summit; tubercle moderate in size and perforated, the areolæ and tubercles increasing gradually in magnitude from the peristome to the upper part of the columns; miliary zone depressed in the middle, and filled with equal-sized granules; line of the sutures well marked throughout.

Spines elongated, cylindrical, subfusiform; stem enlarged at the middle, and tapering at the upper third, summit truncated and presenting a stellate figure; the longitudinal ridges on the stem have a granuliform structure, and the intervening valleys are finely chagreened; the neck is short, distinctly defined, and marked with longitudinal microscopic lines; the head is small, the milled ring prominent, and the acetabulum has a smooth ring around the brim.

Dimensions.—Specimen Pl. X, fig. 2—height, nine tenths of an inch; transverse diameter, one inch and four tenths. Specimen Pl. IX—height, one inch and three tenths; transverse diameter, one inch and nine tenths (?).

PLATE I.

Cidaritis from the Gault and Grey Chalk.

CIDARIS CARTERI, *Forbes*, 1854.

From the Grey Chalk.

FIG.

- 1 *a.* Upper surface, showing the disc, natural size. From the collection of James Carter, Esq. P. 39.
- b.* Lateral view of the same, showing the height of the test and the prominence of the discal elements.
- c.* A single inter-ambulacral plate, with a portion of the ambulacral area and poriferous zones, magnified.
- d.* Apical disc, with the ovarial and ocular plates, magnified.
- e.* Portion of a spine, magnified.
- f.* A small ambulacral spine, magnified.

CIDARIS GAULTINA, *Forbes*, 1854.

From the Gault.

- 2 *a.* Test and spines, *in situ*. British Museum. P. 36.
- b.* Inter-ambulacral plate, magnified two and a half times.
- c.* One large primary spine, natural size.
- d.* A portion of ditto, near the base, magnified twice.
- e.* Stellate terminal portion of a primary spine, magnified.
- 3 *a.* A primary spine, natural size.
- b.* The same, magnified twice.
- 4 *a.* A primary spine, with expanded stem.
- b.* The same, magnified twice.
- c.* A view of the terminal portion.

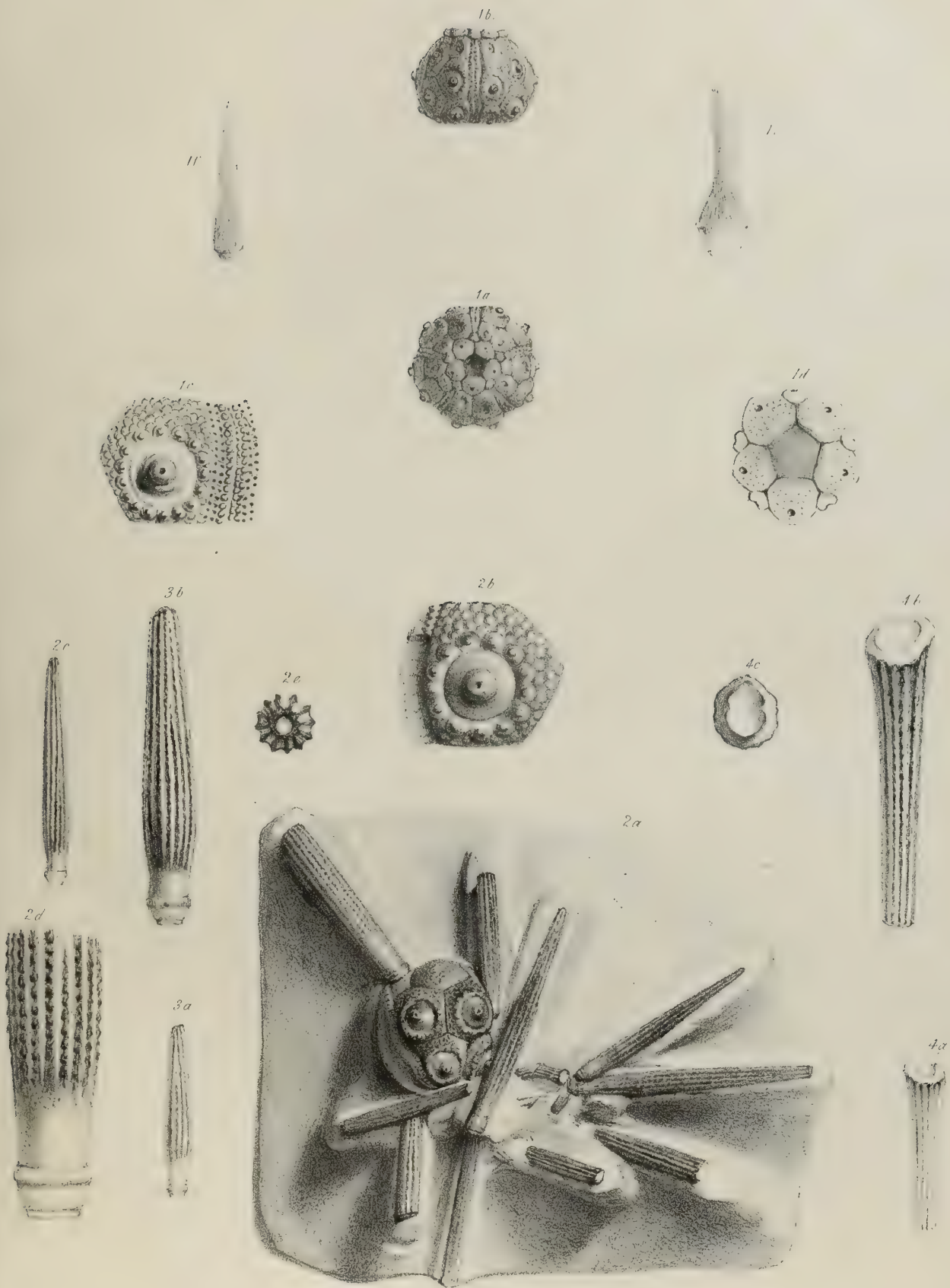


PLATE II.

Cidaritis from the Upper Greensand and Grey Chalk.

CIDARIS BOWERBANKII, *Forbes*, 1850.

From the Grey Chalk.

FIG.

- 1 *a.* Test and spines, *in situ*, natural size, belonging to Dr. Bowerbank, F.R.S. P. 45.
- b.* An inter-ambulacral spine, magnified three times.
- c.* The head, milled ring, and neck, highly magnified.
- d.* A small ambulacral spine, highly magnified.

CIDARIS VELIFERA, *Bronn*, 1857.

From the Upper Greensand.

- 2 *a.* A lateral view of the test, natural size, in the collection of W. Cunningham, Esq., F.G.S. P. 37.
- b.* Basal portion of the same, magnified twice.
- c.* Dorsal portion of the same, magnified twice.
- d.* Lateral view of the same, magnified twice.
- e.* Inter-ambulacral plate, a portion of the ambulacra and poriferous zones, magnified five times.
- f.* A lateral view of a primary tubercle with its circle of areolar granules, magnified.
- 3 *a.* One of the inter-ambulacral spines, natural size.
- b.* The same spine, magnified twice.
- 4 *a.* CIDARIS VELIFERA, a portion of the test and spines, *in situ*, natural size. This unique specimen is in the cabinet of Mr. W. Cunningham.
- b.* The head of a spine, with its milled ring, highly magnified.

CIDARIS VESICULOSA, *Goldfuss*, 1826.

From the Upper Greensand and Grey Chalk.

- 5 *a.* Upper surface of the test, natural size. This specimen from the Upper Greensand is in the possession of W. Cunningham, Esq., F.G.S. P. 41.
- b.* Basal portion of the same test, natural size.
- c.* Lateral view of the same test, natural size.
- d.* An inter-ambulacral plate, with ambulacra and poriferous zones, magnified three times.

CIDARIS FARRINGTONENSIS, *Wright*, 1864.

From the Lower Greensand.

- 6, 7. Single inter-ambulacral plates from the Sponge-Gravel, near Farringdon, magnified two diameters. Museum of Royal School of Mines.
- 8 *a, b, c.* Different inter-ambulacral spines of this species. Museum of Royal School of Mines.
- c, a.* Basal portion of one magnified three times.

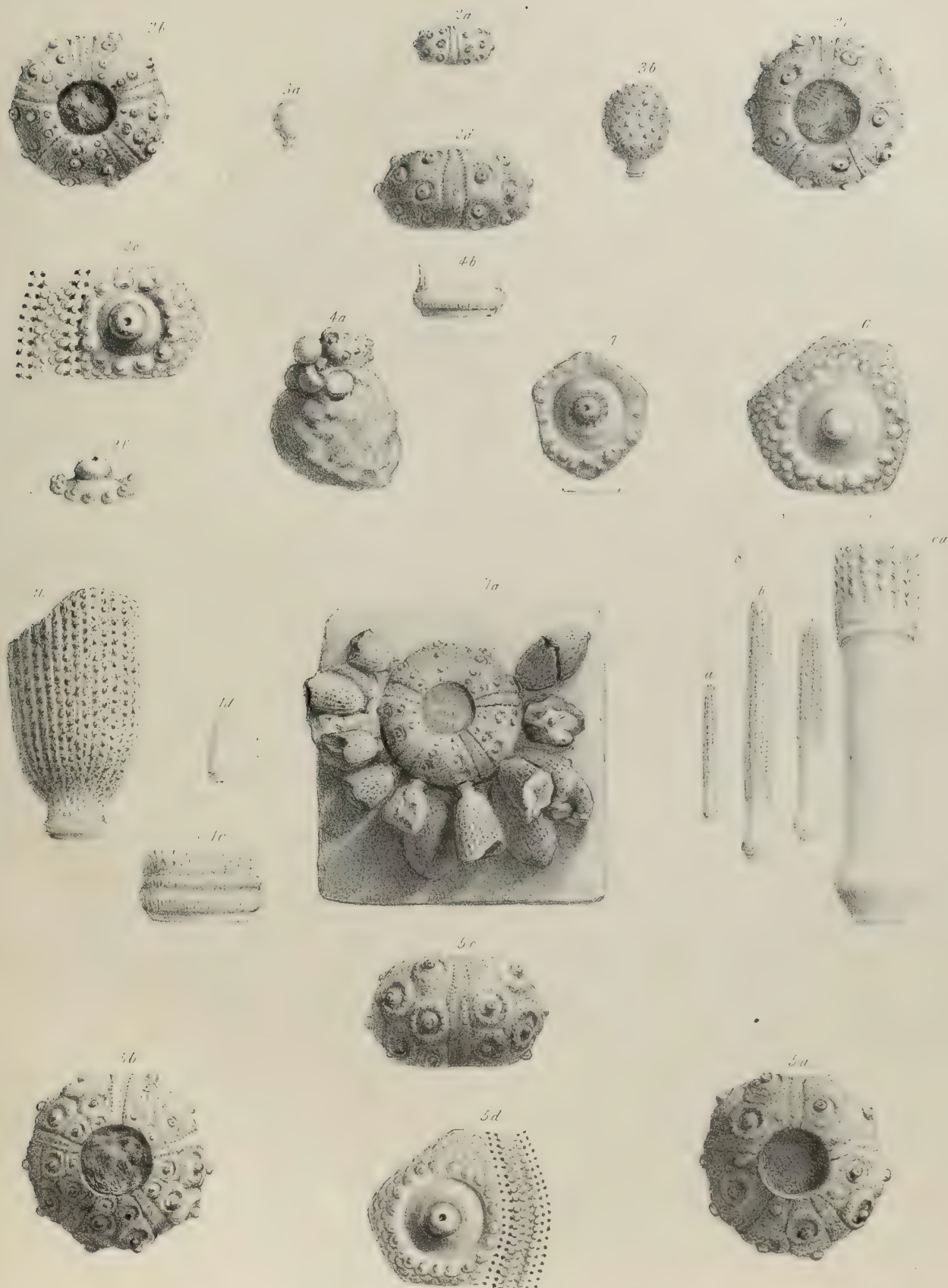


PLATE III.

Cidaris from the Red and Grey Chalk.

CIDARIS VESICULOSA, *Goldfuss*, 1826.

From the Grey Chalk.

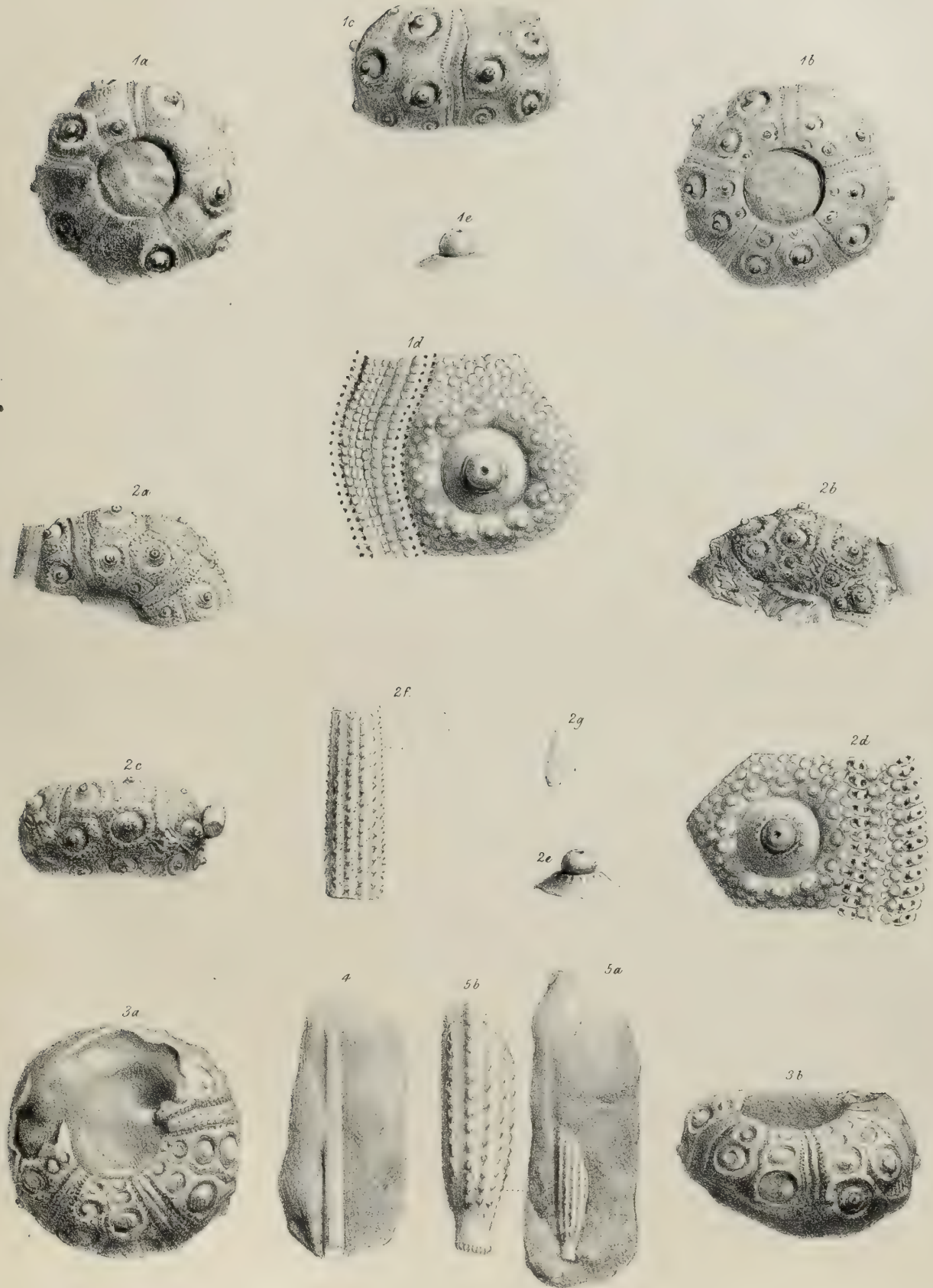
FIG.

- 1 *a.* Under surface of a large test, Grey Chalk, Dover, natural size. British Museum.
P. 41.
- b.* The under surface of the same test, natural size.
- c.* A lateral view of the same test, natural size.
- d.* One inter-ambulacral plate, with a portion of the ambulacra and poriferous zones, magnified three times.
- e.* A primary tubercle, magnified.
- 3 *a.* Test of CIDARIS VESICULOSA (?), from the Red Chalk, under surface, natural size.
In the collection of C. B. Rose, Esq., F.G.S.
- b.* Upper surface of the same test, natural size.
4. Inter-ambulacral spine from the Red Chalk. In the collection of C. B. Rose, Esq.,
F.G.S.
- 5 *a.* Ditto ditto ditto.
- b.* Portion of the same, magnified three times.

CIDARIS DISSIMILIS, *Forbes*, 1854.

From the Lower Chalk.

- 2 *a.* Upper surface of the test, natural size. In the collection of Rev. T. Wiltshire, F.G.S.
P. 46.
- b.* Under surface of the same test, natural size.
- c.* Lateral view of the same test, natural size.
- d.* Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three times.
- e.* A single tubercle, magnified.
- f.* Portion of an inter-ambulacral spine, magnified.
- g.* An ambulacral spine, greatly magnified.



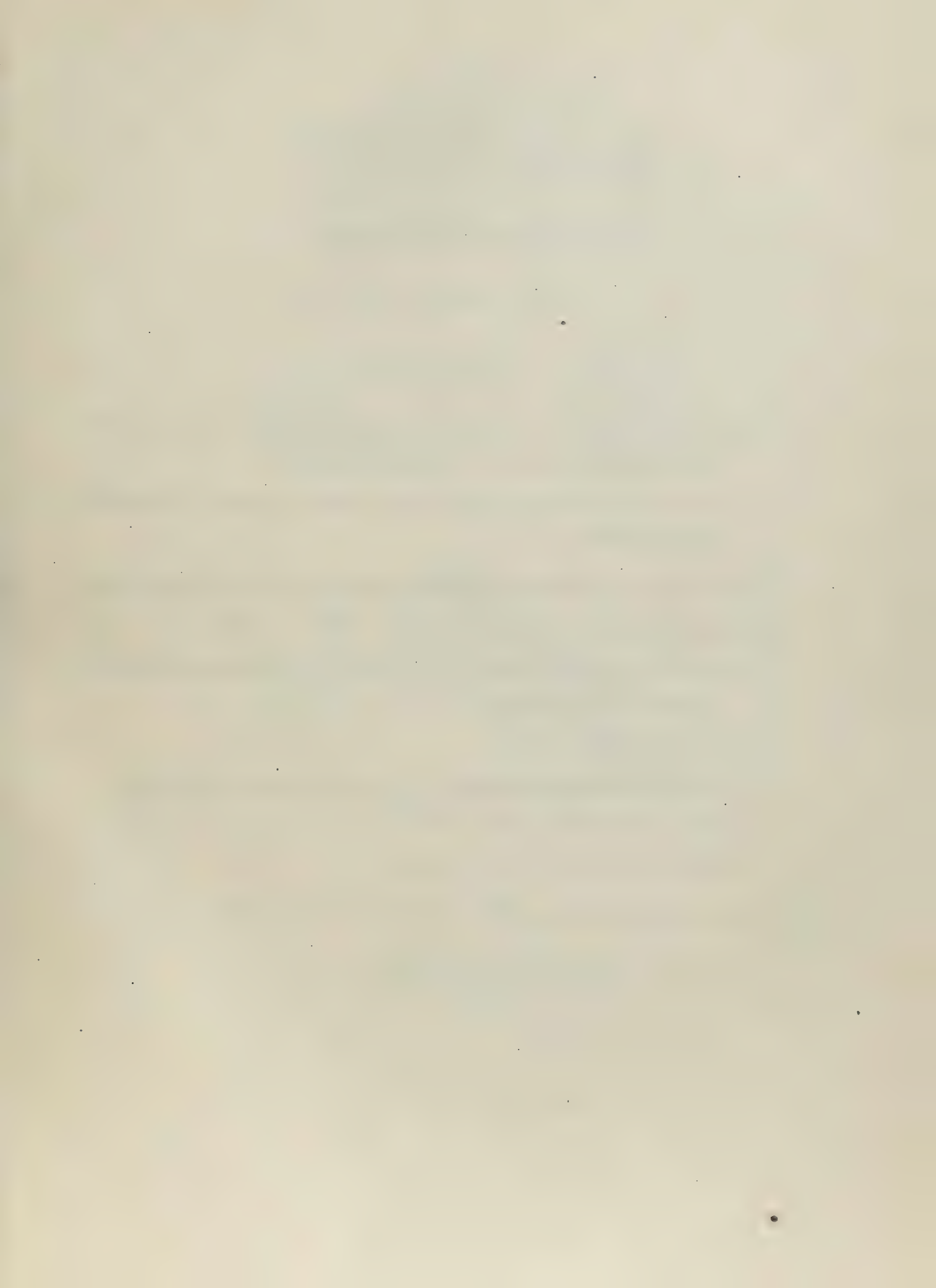


PLATE III *a*.

CIDARIS DISSIMILIS, *Forbes*, 1854.

From the Grey Chalk.

FIG.

- 1 *a*. Upper surface of the test, with spines attached, natural size, from the late Mr. Taylor's collection, now in the British Museum, p. 46.
 - b*. Portion of an inter-ambulacral spine of this species, magnified several diameters. British Museum.
- 2 *a*. Test and spines, upper surface, natural size, belonging to the Rev. T. Wiltshire, F.G.S.
 - b*. Test and spines, under surface, natural size, ditto, ditto.
 - c*. Penultimate inter-ambulacral plate from the upper part of the column, showing the obsolete tubercle and areola.
 - d*. Inter-ambulacral spine, natural size.
 - e*. Portion of the stem, neck, and head, of the same spine, magnified several times.
 - f*. Portion of another smaller spine, magnified.
 - g*. Ambulacral spines, natural size and magnified.
- 3 & 4. Inter-ambulacral spines, natural size, Rev. T. Wiltshire's cabinet.
5. A small test and spine, natural size, ditto, ditto.

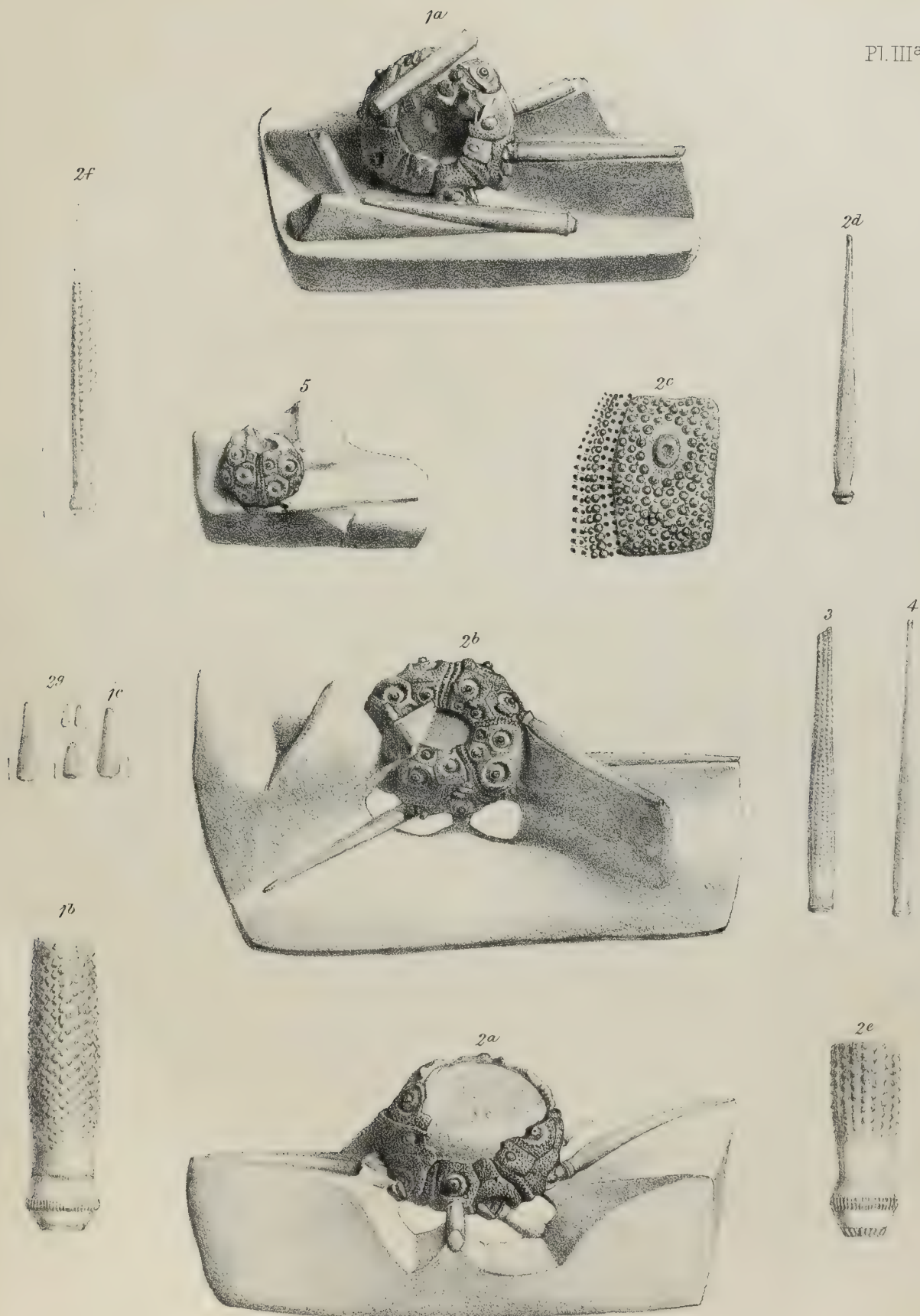


PLATE IV.

CIDARIS CLAVIGERA, *König*, 1822.

From the White Chalk.

FIG.

- 1 *a.* Two tests, with spines, in one block of chalk, natural size. From the late Mr. Taylor's collection, now in the cabinet of Dr. Bowerbank, F.R.S. P. 48.
- b.* Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
- c.* A large tubercle, and circle of areolar granules, magnified.
2. The apical disc, with the ovarial, ocular, and anal plates *in situ*, magnified two diameters.
- 3 *a.* A large inter-ambulacral spine of a typical form, natural size.
- b.* The same, magnified two diameters.
- c.* A portion of the neck of the same, magnified three diameters.
- 4 *a.* A large spine of an abnormal form, natural size.
- b.* A large spine of an abnormal form, magnified two and a half diameters.
- c.* A portion of the neck of the same, magnified three diameters.
- 5—20. Different forms of inter-ambulacral spines, from a series in the collection of Dr. Bowerbank, F.R.S.
21. The neck, milled ring, head, and acetabulum of the specimen figured at 3 *a.*, magnified four diameters.
22. A small ambulacral spine, highly magnified.
23. Another ambulacral spine, highly magnified.

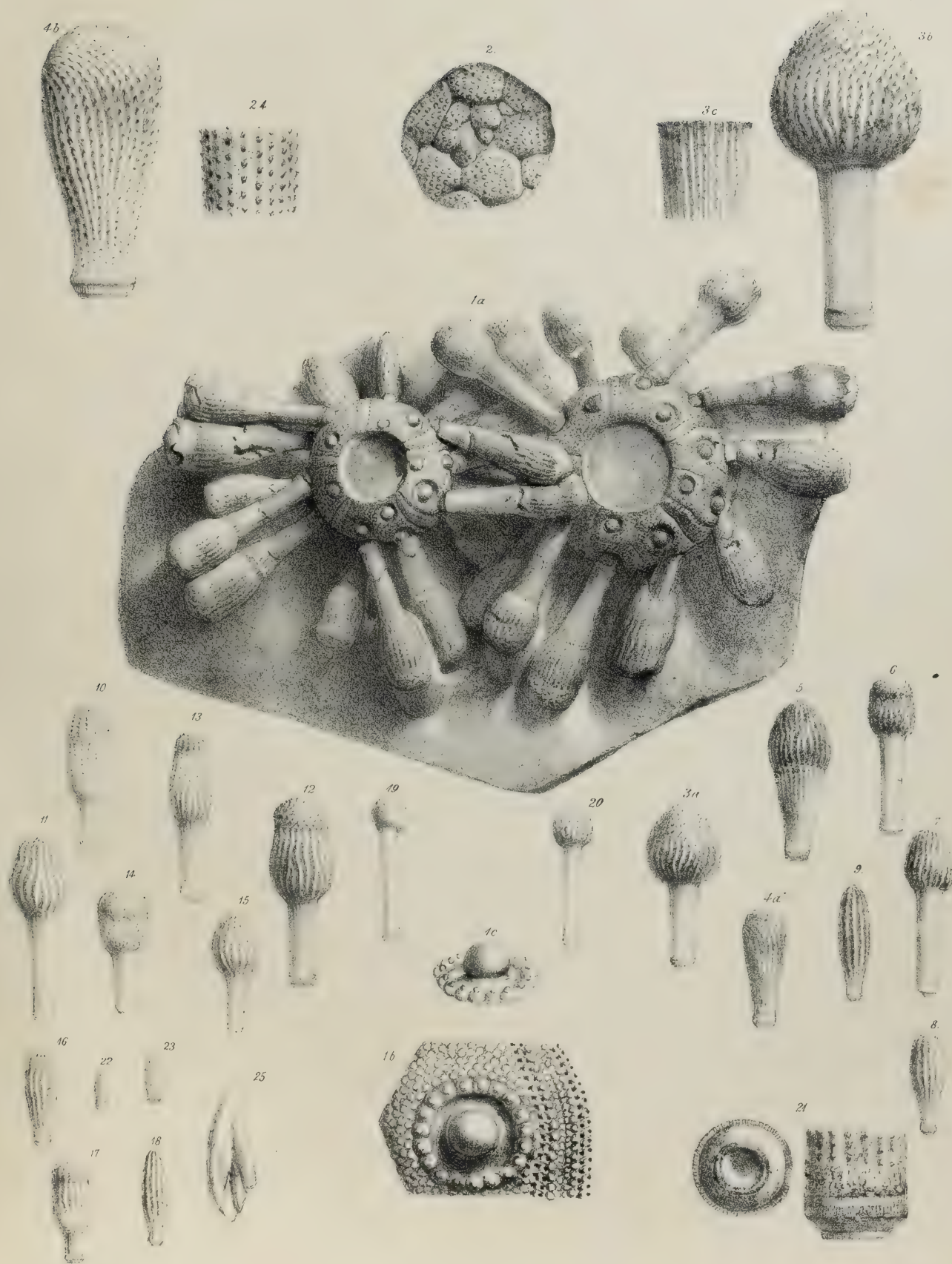


PLATE V.

CIDARIS CLAVIGERA, *König*, 1822.

From the White Chalk.

FIG.

1. Test, with dental organs and spines, natural size. From Mr. Taylor's collection, now in the British Museum. P. 48.
- 2 *a.* Lateral view of a fine test, natural size. British Museum.
b. The under surface of the same, natural size.
3. The apical disc, showing the ovarial, ocular, anal plates, and madreporiform body, magnified two and a half diameters. British Museum.
4. A portion of the peristomal membrane and oral plates, with part of the dental organs, magnified two and a half diameters. British Museum.
- 5 *a.* An abnormal inter-ambulacral spine, natural size. British Museum.
b. The same, magnified, to show the position and form of the canals passing through the stem.
6. An abnormal spine, with summit excavated, natural size. This specimen belongs to the Rev. T. Wiltshire.
- 7—14. Varieties of large inter-ambulacral spines, belonging to the British Museum, natural size. British Museum.
15. A remarkable abnormal form, with an enlarged neck and conical stem and apex, natural size. British Museum.

CIDARIS SCEPTRIFERA, *Mantell*, 1822.

From the White Chalk.

16. Upper surface of a fine test, natural size, with the apical disc *in situ*. This specimen belongs to Dr. Bowerbank's collection. P. 54.
- 17 *a.* Under surface of the same, natural size.
b. Lateral view of the same.



PLATE VI.

CIDARIS SCEPTRIFERA, *Mantell*, 1822.

From the White Chalk.

FIG.

- 1 *a.* Upper surface of the test, natural size. This magnificent specimen belongs to the British Museum. P. 54.
 - b.* Under surface of the same, natural size.
 - c.* Lateral view of the same, natural size.
 - d.* Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
 - e.* The uppermost plate of an inter-ambulacral column, showing the curious rudimentary tubercles, and areola thereon, magnified two diameters.
 - f.* The uppermost plate of the adjoining column, magnified two diameters.
 - g.* A portion of the apical disc, consisting of one ovarial, two ocular plates, and three anal plates, magnified two diameters. The entire disc is seen *in situ*, in fig. 1 *a.*
 - h.* Three anal plates, magnified two diameters.
2. Test with spines, natural size. This specimen belongs to the Museum of the Royal School of Mines.
- 3 *a.* Spine, type form, natural size.
 - b.* The upper part of the stem, magnified three diameters.
 - c.* The stellate form of the terminal extremity, magnified three diameters.
- 4 *a.* Spine, type form, natural size.
 - b.* The head, neck, and milled ring of the same, magnified three diameters.
- 5 *a, b.* Another spine, natural size.
6. A variety. Specimens 3, 4, 5, and 6, belong to the British Museum.

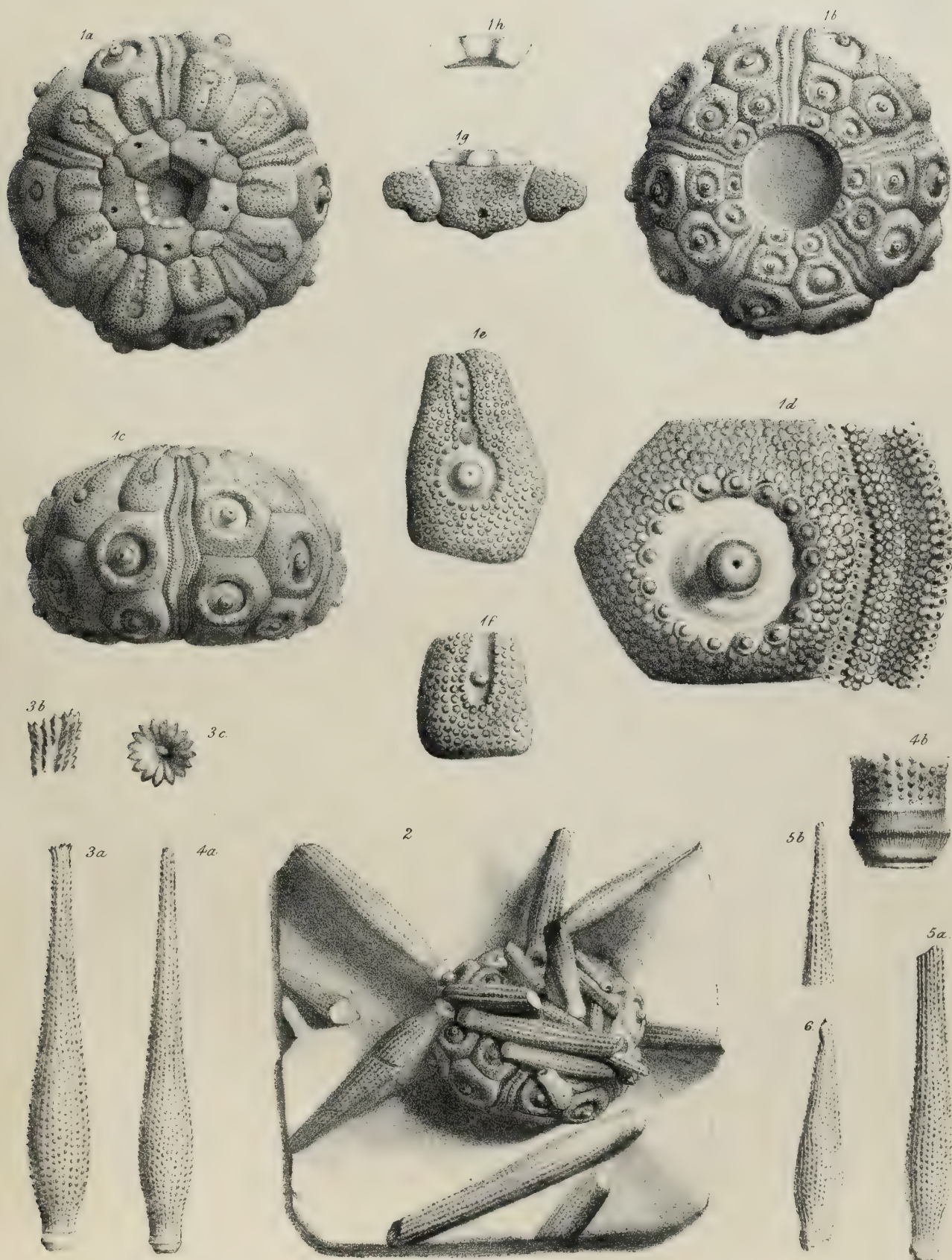


PLATE VII.

CIDARIS SCEPTRIFERA, *Mantell*, 1822.

From the White Chalk.

FIG.

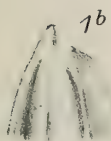
- 1 *a.* Test, dental organs, and spines, *in situ*, natural size. From the late Mr. Taylor's collection, now in the Museum of the Royal School of Mines. P. 54.
- b.* Dental apparatus and teeth, magnified two diameters.
- c.* Ambulacral spine, greatly magnified.
2. Spine of *C. sceptrifera*, variety. From the cabinet of the Rev. T. Wiltshire, F.G.S.

CIDARIS PERORNATA, *Forbes*, 1850.

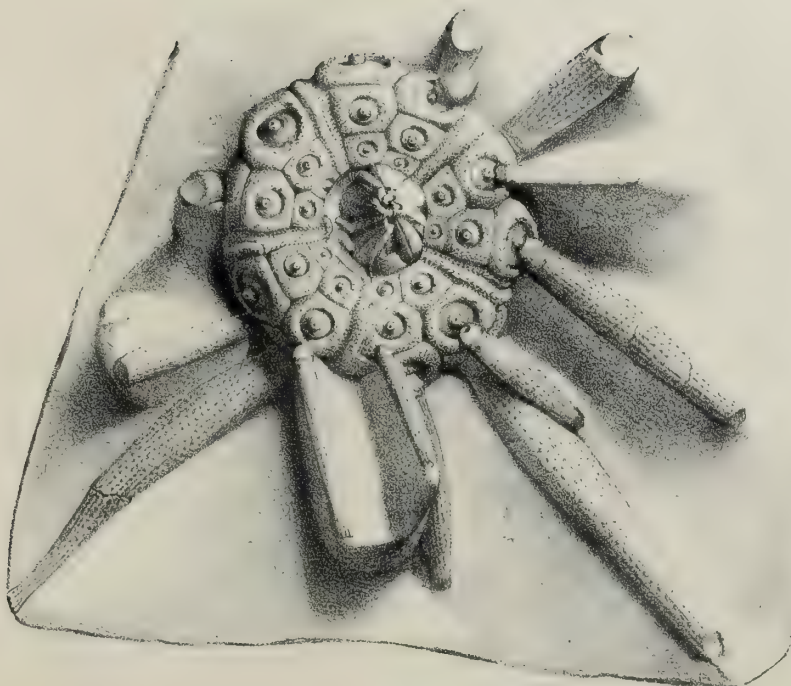
From the White Chalk.

- 3 *a.* Lateral view of the test, natural size. In the British Museum. P. 62.
- b.* Under surface of the same, natural size.
- c.* Interambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
- d.* Lateral view of a primary tubercle, magnified.
- 4 *a.* Inter-ambulacral spine, natural size. Museum of the Royal School of Mines.
- b.* Stem, neck, head, and milled ring, magnified three diameters.
- c.* A portion of the stem, magnified six diameters, to show the spiny ridges and the longitudinal lines in the valleys.

1a



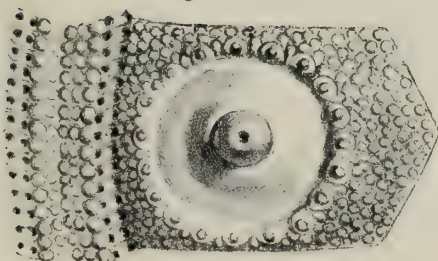
1c



2



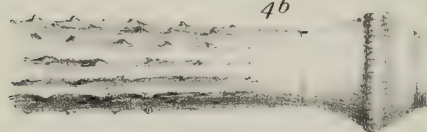
3c



3d



4b



4a



3b



4c



3a

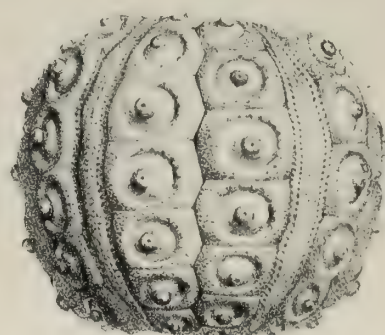




PLATE VII *a*.

CIDARIS SCEPTRIFERA, *Mantell*, 1822.

From the White Chalk.

FIG.

- 1 *a*. Test and spines, *C. sceptrifera*, var. *filosa*, from the White Chalk of Gravesend, natural size, presented to the British Museum by the Rev. Norman Glass, F.G.S. P. 54.
 - b*. Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
 - c*. A thickened variety of spine, magnified two diameters.
3. Spine of *C. sceptrifera*, var. *filosa*, belonging to the Rev. Thos. Wiltshire, F.G.S.

CIDARIS PERORNATA, *Forbes*, 1850.

From the White Chalk.

- 2 *a*. Under surface of a large *C. perornata*, restored from the Rev. Thos. Wiltshire's specimen, now in his cabinet. P. 62.
- b*. Lateral view of the same.

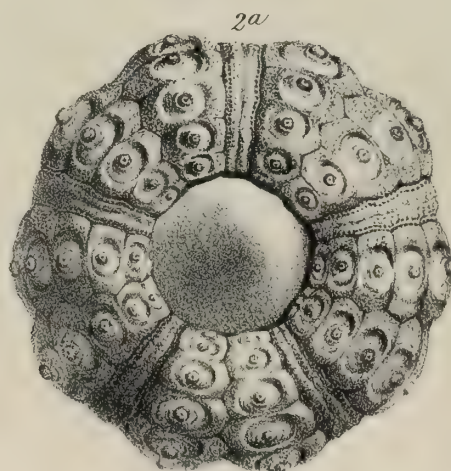
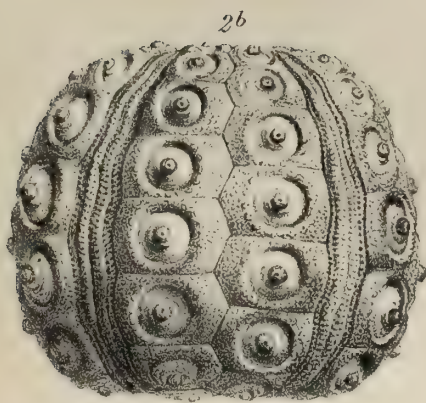
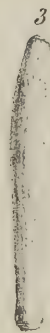
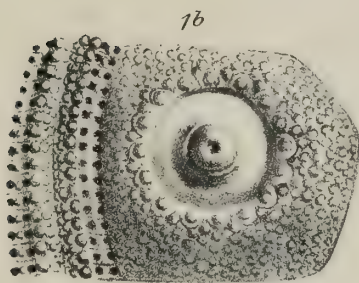
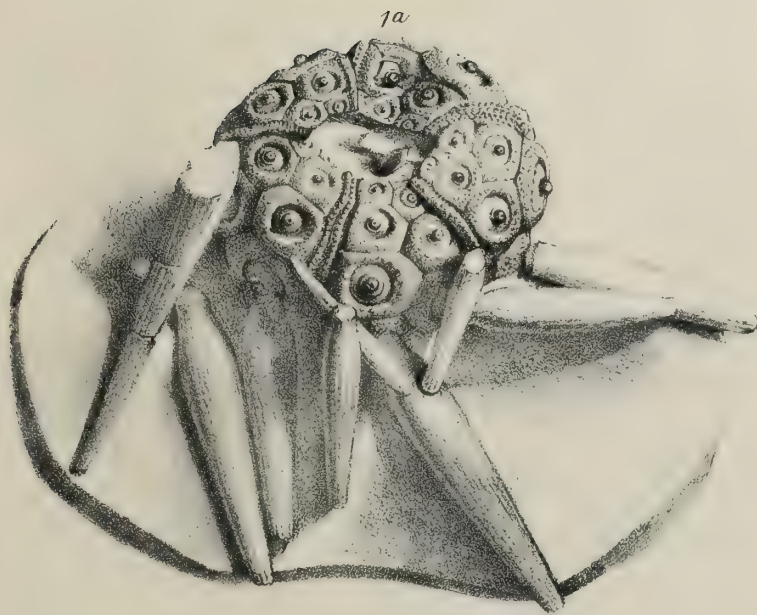


PLATE VIII.

CIDARIS MERCEYI, *Cotteau*.

From the White Chalk.

FIG.

- 1 *a.* Under surface of the test, natural size. In the possession of Dr. Bowerbank, F.R.S.
P. 60.
 - b.* Lateral view of the same, natural size.
 - c.* Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
 - d.* A lateral view of the same plate, magnified three diameters.
 - e.* A penultimate plate, from the upper part of one of the inter-ambulacral columns, showing the small rudimentary tubercle and areolæ, magnified three diameters.
 - f.* A small inter-ambulacral plate, near the peristome, magnified three diameters.
 - g.* A portion of an ambulacral area, and poriferous zones, magnified five diameters.
- 2 *a.* Inter-ambulacral spine, natural size.
 - b.* A portion of the stem, magnified two and a half diameters.
 - c.* The head, neck, and part of the stem, magnified two and a half diameters.
3. A small inter-ambulacral spine, natural size.

CIDARIS SUBVESICULOSA, *d'Orbigny*.

From the White Chalk.

- 4 *a.* Upper part of the test, and apical disc with one spine, *in situ*, natural size. From the collection of Dr. Bowerbank, F.R.S. P. 57.
 - b.* A plan of the apical disc, showing the parts that are absent in the preceding figure.
5. Lateral view of a smaller test. Dr. Bowerbank's collection.
6. An ambulacral spine, highly magnified.

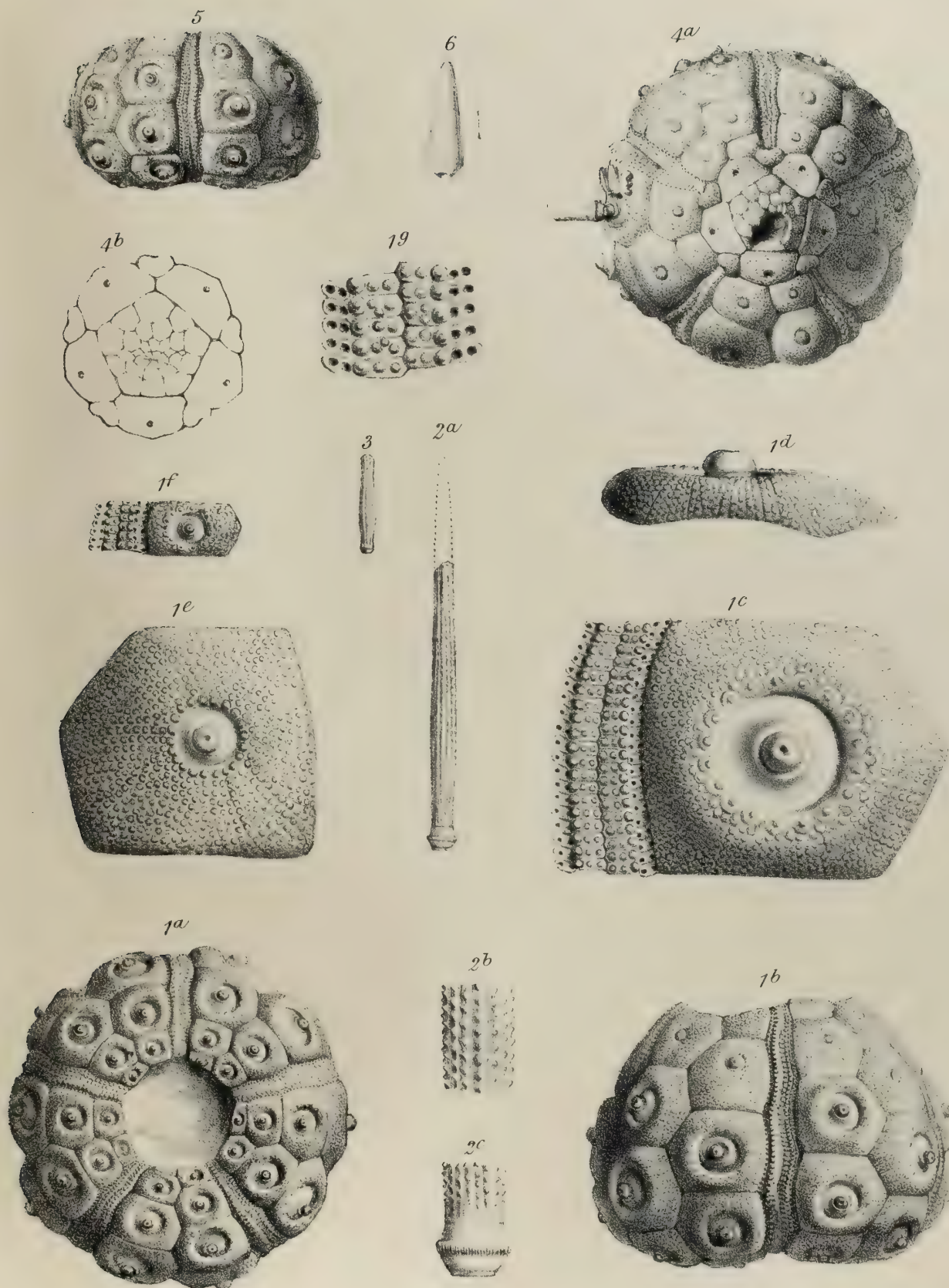




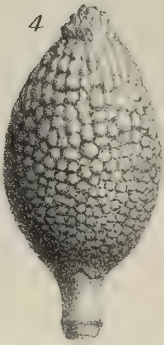
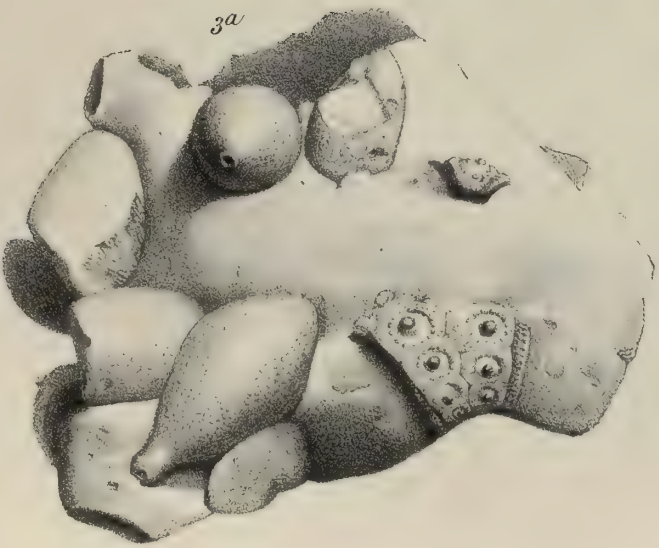
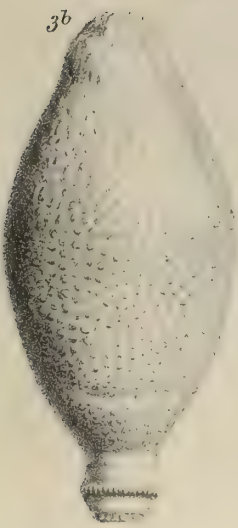
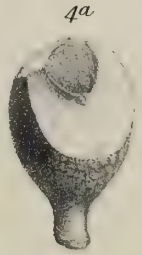
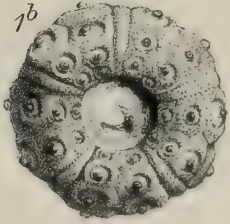
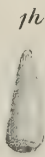
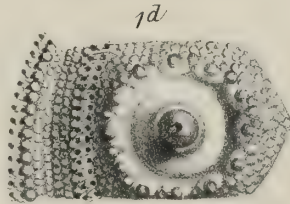
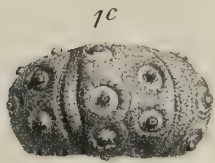
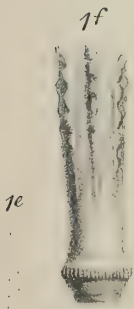
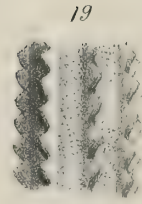
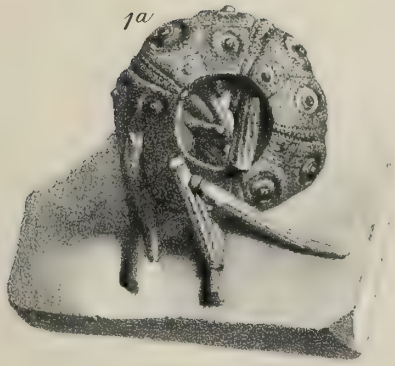
PLATE XI.

CIDARIS SERRIFERA, *Forbes*, 1850.

From the White Chalk.

FIG.

- 1 *a.* Test and spines, natural size. Collection of Henry Willett, Esq., F.G.S. P. 51.
b. Under surface of the same test, natural size.
c. Lateral view of the same, natural size.
d. Inter-ambulacral plate, ambulacra, and poriferous zones, magnified three diameters.
e. Inter-ambulacral spine, natural size.
f. Stem, neck, and head of the same, magnified three diameters.
g. Portion of the stem, highly magnified, to show the serrated spines and intervening sulci. In the cabinet of Dr. Wright.
h. Ambulacral spine, highly magnified.
2. Portion of a spine of *C. serrifera*, magnified. Collection of Professor Tennant, F.G.S.
- 3 *a.* Spines of *Cidar*is. British Museum.
b. One of the spines, magnified two diameters.
4. *CIDARIS DIXONI*, *Cotteau*, 1862. Inter-ambulacral spine, natural size. From the Grey Chalk of Dover. Collection of Henry Willett, Esq., F.G.S.
a. A section of another specimen, to show the cavity in the stem.
5. *CIDARIS PLERACANTHA*, *Agassiz*. Spine, natural size. British Museum.
6. Spines of *Cidar*is, natural size, and magnified twice. British Museum.



THE
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A MONOGRAPH
OF
BRITISH TRILOBITES.

BY
J. W. SALTER, A.L.S., F.G.S.,
LATE OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1864.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

CORRIGENDA.

In page 14, line 18, *for* Emmerich, "1845," *read* "1839."

„ „ 13, *for* "ost," *read* "lost."

„ 37, at bottom, *add* the following synonym :

“CHASMOPS ODINI, *Hoffmann*. Trilob. Russlands Verhandl. Kaiserl. Miner. Gesellsch
zu St. Petersburg, 1858, t. iv, fig. 7.

„ 39, *for* "fig. 7," *read* "fig. 9."

„ 44, line 4, *for* "VII," *read* "VI."

„ 59, „ 3, *add* synonym, "*Salter*, in Decades of Geol. Survey, No. 2, Article *P. caudatus*,
p. 8, (see line 16)."

„ 64, line 13, *omit* fig. 10.

A MONOGRAPH

OF

BRITISH TRILOBITES.

A MONOGRAPH of the British species of the Trilobite group has long been desirable, and would, in accordance with the wish of many friends, have been prepared by me before now, had public engagements permitted it.

The materials for such a work have hitherto been much scattered; nevertheless, of late years, they have become very numerous, whilst the publication of such sterling works as those of Barrande, Burmeister, Beyrich, and Lovén, have disposed naturalists, as well as geologists and collectors, to pay increased attention to the group,

I think that a true and natural arrangement of the Trilobites is yet to be given; and therefore prefer at present to publish the materials in hand, that in the mean time systematic zoologists may have the means of forming their judgment. The group is a very complete one, and no artificial scheme is admissible for its classification. Dr. Emmerich's Essay, of 1845, seems to me to be the nearest approach to a natural grouping of the families; and I shall follow it meanwhile, in figuring the species,¹ with such additions as are proposed on the next page. The dichotomous arrangement here given is proposed merely as temporary; but I believe it to be, in the main, a natural one.

And I trust that, by the time we have arrived at the conclusion of the work, some new and clearer light may be thrown on the affinities and arrangement of this order of Crustacea, as unique in character as it is well defined in geological place.

¹ Our friends will much oblige by forwarding us their best specimens, including any illustrative fragments, in the order of the families as given on page 2. In that way all the materials for a genus will be under the eye together, and no long detention of the specimens need take place. They may be sent to my care, at Mr. SOWERBY'S Natural History Offices, 45, Great Russell Street, London.

PRELIMINARY CLASSIFICATION OF TRILOBITES.

I have here given chiefly British genera as examples. There are, of course, many others. It is evident that the lowest and most rudimentary group of all is that of the *Agnostidæ*, which, therefore, may be at once placed at the base; and there is not likely to be much difference of opinion as to the place of the *Phacopidæ*, as the typical and most perfect group of the order. The other genera fall more or less naturally into an intermediate place, but are developed along two distinct lines, as follows:

A. —Trilobites with facial suture ending on the external margin. Eyes well developed, usually faceted externally. (Phacopini.)	1. PHACOPIDÆ. Phacops. Trimercephalus. Acaste. Chasmops. Odontochile. Cryphæus.	
	2. CHEIRURIDÆ. Cheirurus. Staurocephalus. ? Cybele. Sphærexochus. Deiphon. ? Enerinurus. Amphion. ? Zethus.	
B. —Facial suture ending on the posterior margin. Eyes (usually) moderately developed, smooth. (Asaphini.)	3. ACIDASPIDÆ. Acidaspis, &c.	12. PROETIDÆ. Brachymetopus. Griffithides. Phillipsia. Proetus. Phaeton.
	4. LICHADÆ. Lichas.	11. BRONTEIDÆ. Bronteus.
7. CALYMENIDÆ. Calymene. Homalonotus.	5. CYPHASPIDÆ. Cyphaspis. Aulacopleura, &c.	10. ASAPHIDÆ. Illænus. Nileus. Stygina. Isotelus. Asaphus. Ogygia. Barrandia. Basilicus. Niobe. Psilocephalus.
8. CONOCEPHALIDÆ. Conocoryphe. Sao. Solenopleura. ? Centropleura. Holocephalina. Angelina.	6. HARPEDIDÆ. Harpes.	
	9. OLENIDÆ. Olenus. Remopleurides. Sphærophthalmus. Triarthrus. Paradoxides. Tiresias. Anoplenus. Cyphoniscus. Hydrocephalus.	Æglinia.
C. —Facial sutures obscure, or submarginal, or none. Eyes often absent. (Amphypycini).		13. TRINUCLEIDÆ. Dionide. Trinucleus. Ampyx.
	D. —Without eyes or facial suture. (Agnostini.)	14. AGNOSTIDÆ. Agnostus. Trinodus.

Number of body-rings considerable.
Caudal portion reduced.

Number of body-rings reduced. Caudal portion proportionally enlarged.

BRITISH TRILOBITES.

HISTORY.—Professor Burmeister has given a very full account of the authors who have written upon this subject, in his celebrated treatise on the ‘Organisation of Trilobites,’ published at Berlin in 1843, and translated for the Ray Society by Prof. Thomas Bell and the late Prof. Edward Forbes.

A short summary of the Professor’s observations will be sufficient for our purpose, for the book is widely circulated, and is indeed the only summary to which we can turn for full information. He has enriched it with a full bibliography collected by himself, and traced the work done by successive naturalists and geologists to the time of Emmerich’s scientific treatise in 1839,¹ and Milne-Edwards’ Catalogue, in his volumes on the ‘Crustacea.’

It would seem that our own countryman Dr. Llhwyd was really the first to call attention to the “regularly figured stones lately found by him,” but though he referred them to “the skeletons of some flat fish,” he took good care to explain that “not these or any other marine terrestrial bodies were really parts of animals,” and he only marvelled that the “*Piscis Icon*” should be raised above the surface of the stone “*ac si verus piscis esset.*” This view of the fossils was about as correct as most of those which followed till the time of Linnæus, although Mortimer and Da Costa had declared in favour of their crustacean origin. It was Walch’s ‘Natural History of Petrifications,’ published at Nuremberg in 1771, which first brought into a focus the scattered information regarding the group, and established the views of Da Costa, Linnæus, Wilkens, and other writers who had regarded Trilobites as entomostraca. Walch first gave them the name of Trilobites, and Parkinson’s figures and the descriptions of several German authors pointed out the necessity of distinguishing the species.

¹ Reproduced with improvements in 1845. This is the earliest scientific arrangement of the tribe : See Leonhard und Bronn’s ‘Jahrbuch,’ 1845.

In 1821, two distinguished French naturalists entered this field. Latreille, whose fame as a student of the *Articulata* needs no illustration, strangely enough overlooked the manifest characters which placed the Trilobites among Crustacea, and pronounced for their affinity with *Chiton*. Audouin, on the contrary, compared them with the Isopod Crustacea, declared they had no feet, but appendages for breathing organs, and, in short, led the way, as Burmeister admits, for all subsequent research in the same direction.

Then followed Wahlenberg's work, and Brongniart's '*Histoire Naturelle des Crustacés*,' a work in which the genera of Trilobites were first defined, and seventeen species described. Schlotheim soon raised these to twenty-six, and Dalman's complete treatise on the group in 1826 gave a new importance to the subject; while the very perfect state of the Swedish specimens enabled him to present better figures than had before appeared. He called the group *Paleadæ*, and altered some of the generic names without much reason, but in this he has not been followed.

De Kay in America, and Count Sternberg in Germany, meanwhile, described many forms; and Eichwald and Razumovsky, in Russia, prepared the way for Dr. Pander's careful treatise, in which the labrum, first observed by our countryman Charles Stokes in American specimens, was fully described.

Dr. Green's monograph, in 1832, was only valuable for the casts which illustrated it; and up to the time of the publication of the '*Silurian System*,' in 1837, but very little was known about Trilobites in England. That work, however, had a wide fame, and deservedly so, and by costly illustrations of the best specimens procurable, and by the philosophic remarks contributed by Dr. McLeay, gave a new impetus to the collection and description of the species. Dr. Buckland, a year before, had illustrated some of the more common kinds in his '*Bridgwater Treatise*.'

But the period was now coming for the scientific arrangement of the facts collected. Illustrations were abundant both in England and on the Continent, especially in Sweden and Norway, where Sars and Boeck, Esmark, Hisinger, and other authors, had done their best to make the Scandinavian species known. About 1837 Prof. Burmeister began to turn his attention to the group, and Dr. Quenstedt, of the Mineralogical Museum of Berlin, published some important observations with regard to the number of rings in the body, which Burmeister justly regards as of great consequence. It is doubtful whether the honour belongs to Burmeister or Quenstedt of first calling attention to this, the chief means of distinguishing the various genera, as well as a point of great importance in determining the affinity. Dr. Burmeister, at all events, suggested it to Quenstedt, and afterwards worked it out, considering that Trilobites differ from all other Entomostraca in having no definite fundamental number of segments to the thorax, while the living Entomostraca and Malacostraca are ruled by different but always definite numbers.

While these investigations were going on, Dr. Emmerich succeeded Dr. Quenstedt in the care of the Berlin Museum, and followed out his researches by a complete and beautiful essay, well known as the '*Dissertatio Inauguralis*,' Berlin, 1839. In this work the author,

while ranging over the more recondite portions of the study, threw for the first time the whole Trilobite group into a series of natural families. And these must be, I conceive, the basis of any true classification of the order *Trilobita*. The separation of the large-eyed Trilobites with eleven body-rings, was not indeed due to Emmerich, but to Quenstedt; but Dr. Emmerich's essay confirmed this important view, named the group Phacops—our first described one, and went on to apply the principle thus gained to the arrangement of the whole. The species are carefully made out, the synonyms collected, and a model set for all succeeding works.

Other observers were not idle. Von Buch, Bronn, Green, Goldfuss, and Münster were figuring the new species with various merit; and Milne-Edwards had compiled all the known synonyms in his great work on the Crustacea. In 1843, three most important works appeared, in one of which Dr. Burmeister placed before the German reader all the facts regarding the history, structure, and affinities of the group, while Dr. Goldfuss gave a systematic arrangement of Trilobites and description of new species in the 'Jahrbuch' for 1843. In England, the profound and careful work of the late Gen. Portlock first called attention to all the new discoveries which had been making abroad, while the many new forms which he described and illustrated¹ have given his work the very highest rank. The American species began now to be figured by Hall, and Emmons, and Vanuxem; Lovén was producing his classic descriptions in the Transactions of the Swedish Academy. (Ofvers. Kongl. Vetensk. Akad., 1844, &c.); Emmerich repeated and improved his classification in the 'Neues Jahrbuch' for 1845; Dr. Beyrich, in 1846, was giving us his accurate descriptions of species; and in the same year appeared the 'Notice Préliminaire' of M. Barrande, the herald of a work which has thrown nearly all other works on trilobites into the shade.

This remarkable sketch by M. Barrande, the fruit of thirty years of labour, indicated at once the commencement of a new era for the group. A supplement published by M. Barrande the same year raised the number of described Bohemian species alone to 152. The rich "terrain" which M. Barrande has so emphatically made his own still furnished abundant work for Beyrich; and M. Corda, the keeper of the National Museum at Prague, even attempted to snatch the "spolia opima" from the hand that had won them. The 'Prodrom einer Monographie der Bohmischen Trilobiten,' while it attests the rapid industry of the well-known botanist of Prague, shows how little is gained by hasty generalisation, and especially "appropriation" in natural history. It was a melancholy failure. While M. Barrande had patiently traced the metamorphosis of some thirty different kinds of Trilobites, and was preparing for their illustration, these young and undeveloped Trilobites were figured by Corda as so many distinct genera and species. A certain number of new forms were doubtless named, and a few errors of nomenclature corrected; but the absurd

¹ His illustrations do not do him justice. Owing to a misfortune of the printers, the whole of the beautiful plates drawn for the work by Mr. G. V. Dunoyer had to be hastily transferred by an employé, and the character is greatly lost in the transfer.

mistake of grouping the Trilobites according to the pattern of their tail-fringes, instead of following Emmerich's natural arrangement, was committed in presence of such materials as Emmerich probably never saw !

Angelin's first instalment of the Swedish Trilobites, appeared in 1852, after many memoirs by Beyrich, and Lovén, and Kutorga, and Volborth, on the Swedish or Russian forms ; but it is impossible to notice all the works that followed Emmerich's essay. M'Coy, and Fletcher, and Prof. Wyville Thomson, and myself, have done our best, as opportunity offered, to illustrate the British forms after Portlock's model in 1843. The Decades of the survey by E. Forbes and J. W. Salter appeared in 1849 and 1853. In the last-named year, M. Barrande's long-expected volume made its appearance, and in its illustrations and descriptions of 250 Trilobites is a work without a rival. He is now preparing the second volume, which will add some fifty or sixty more. But as he will be referred to in every chapter that follows, it is not necessary to say more of his work here. On one point only has the author left the field open. He has honestly and modestly stated that he does not profess to *classify* the Trilobites ; and on this point we are therefore free to follow Dr. Emmerich as before.

The years 1855 to 1863 have seen great additions to our knowledge of Trilobites made from all quarters : the primordial zone has yielded up its treasures to the search of English and American geologists, and has received additions from all parts of North Europe.

A formation utterly unknown to science till Barrande established its history has proved to be a most extensive and rich repository for Trilobites. Barrande in Bohemia and Spain, Angelin in Sweden, myself in Britain,—Logan and Dale Owen, and Billings, and more lately James Hall, in the New World, have contributed materials from this most ancient zone of life—the Cambrian. And if of late years systematic classification has not kept pace with the description of the forms, the fault has not been with the palæontologist in neglecting to supply the data.

GEOLOGICAL PLACE.—The geological history of the Trilobite group is very clear and succinct. Though not the oldest animal forms known, they meet us in the earliest formation in which we have any abundant traces of marine life, viz., the Lingula-flags (Cambrian of *Sedgwick*; Upper Cambrian of *Lyell*, Lowest Silurian of *Murchison*).

In this their commencement we have some of the smallest and most rudimentary, as well as some of the largest forms ; but the group did not attain its maximum, nor rise to its most perfect forms, till the period of the Llandeilo and Caradoc formations—the typical Lower Silurian deposits.

Above this point few new types were introduced ; and though individuals were numerous and species most abundant, there were fewer *genera* in the Upper than in the Lower Silurian. In the Devonian the reduction went still further. In the Carboniferous Limestone they were reduced to three genera ; and the group was extinct before the later portion of the Coal-period.

As the Trilobites will be constantly referred to the special groups of beds in which

they occur, it may be well to give, in a short tabular form, the Palæozoic arrangement followed in this work, with the distribution of the Trilobites as to maximum and minimum in these zones.

The Palæozoic groups are nearly those adopted of late years by our leading geologists. For the determination of the lower ones we are almost equally indebted to Murchison and Sedgwick, and their labours since 1831 have now become the common property of the scientific world.

GROUPS.		UPPER PALÆOZOIC.		TRILOBITES.
CARBONIFEROUS.	PERMIAN	{ Magnesian Limestone, &c. Pontefract Sandstone	None.	
	{ UPPER CARBONIFEROUS	{ Upper Coal Measures		Extremely rare.
		{ Lower Coal Measures		
		{ Millstone Grit		
	{ LOWER CARBONIFEROUS	{ Yoredale Rocks	Three genera only.	
		{ Mountain Limestone		
{ Carboniferous Slate				
MIDDLE? PALÆOZOIC. ¹				
DEVONIAN.	{ UPPER DEVONIAN	{ Pilton and Marwood group (Upper Old Red Sandstone).....	Few genera ; few species.	
		{ Petherwin group		
	{ MIDDLE DEVONIAN.....	{ Plymouth group (Middle Old Red Sandstone)	Few genera ; many species.	
		{ Linton and Fowey group (Lower Old Red Sandstone)		
	{ LOWER DEVONIAN	{ Ledbury Shales (Passage Beds)	Few genera ; many species.	
LOWER PALÆOZOIC.				
UPPER SILURIAN.	{ LUDLOW	{ Upper Ludlow (<i>Murchison</i>)	Few genera ; abundant species.	
		{ Aymestry and Lower Ludlow (<i>Murchison</i>)		
	{ WENLOCK.....	{ Wenlock Limestone (<i>Murchison</i>) ...	Many genera ; abundant species.	
		{ Wenlock Shale (<i>Murchison</i>)		
		{ Woolhope Limestone (<i>Murchison</i>) ...		
		{ Denbighshire Grits (<i>Sedgwick</i>)		
{ MAY-HILL.....	{ May-hill Sandstone (<i>Sedgwick</i>); Up- per Llandovery (<i>Murchison</i>)	Many genera and species.		

¹ This term is introduced in deference to published authorities. But the Upper and Middle Palæozoic groups are together only equivalent to the Lower, and might well be all included under the one term "Upper Palæozoic."

GROUPS.		LOWER PALÆOZOIC,— <i>continued</i> .	TRILOBITES.
LOWER SILURIAN.	LLANDOVERY	Lower Llandovery Rocks (<i>Murchison</i>)	Many genera and species.
	CARADOC	{ Caradoc Rocks (<i>Murchison</i>); Upper Bala Rocks (<i>Sedgwick</i>)	Maximum of species and genera.
	LLANDEILO	{ Upper Llandeilo Flags (<i>Murchison</i>); Lower Bala (<i>Sedgwick</i>)	
	ARENIG	{ Arenig group and Skiddaw group (<i>Sedgwick</i>); [Lower Llandeilo, <i>Murchison</i> ; Quebec group, <i>Lo- gan</i> , in part]	Abundant genera and species.
CAMBRIAN.	TREMADOC	{ Upper Tremadoc (<i>Salter</i>)	Many genera and species.
		{ Lower Tremadoc (<i>Salter</i>)	
	FESTINIOG	{ Upper Lingula Flags (<i>Salter</i>)	Few genera; many species.
		{ Lower Lingula Flags (<i>Sedgwick</i>) ...	
	LONGMYND	{ Barmouth and Harlech Sandstones (<i>Sedgwick</i>)	One genus? one species?
	{ Llanberis Slates (<i>Sedgwick</i>)		
LAURENTIAN AND AZOIC ROCKS.			

STRUCTURE AND HABITS.—Of their natural history I do not intend to say much here, as I think it foreign to the purpose of this work to discuss such points at length, the chief object of the Palæontographical Society being to collect accurate figures and descriptions of the species of British fossils. I shall, at all events for the present, content myself with very few remarks; and chiefly for the use of the general reader.

I need only say, then, that Prof. Burmeister contends that Trilobites belong to the Entomostraca, or lower division of the Crustacea, from the numerous (not definite) number of the segments of the body, and is disposed to place them among the Phyllopoda. The learned McLeay, in his discussion of their affinities in the 'Silurian System,' gave them a higher position, intermediate between the Isopodous group and the Phyllopods;¹ and it is pretty certain that they form a distinct order, and do not belong to any modern group of Crustacea.

Every author who has written on Trilobites has more or less perceived their analogy with the *Limulus* or King-crab, to which tribe there is, indeed, a good deal of external

¹ McLeay was, of course, not aware of the metamorphosis of the Trilobite, since made out by M. Barrande. He characterises them as having the "head distinct, without antennæ; the feet rudimentary, soft, and almost useless." His judgment, as to their habits, is suggestive, and, at the same time very cautious. He evidently thought it likely they had no feet at all; and I give his remarks in brief. "Whether they moved (they were probably to a certain degree sedentary) by soft, rudimentary feet, by undulation of setigerous segments, as the worm moves, or by an undulation of the lower soft surface, as in *Chiton*, is uncertain. They probably adhered in masses, as *Chitons* do; and, as the mouth is like that of *Apus*, they were probably carnivorous, as is that genus, and may have fed on *Acrita*, *Annelida*, or naked *Mollusca*."

resemblance. But this resemblance totally fails when we examine the under side of the animal; for all the researches hitherto made (and they are many) fail to detect the slightest trace of limbs in the Trilobite. It is impossible, seeing the state of preservation in which they occur, to suppose that in every case,—in fine shale, in limestone, in arenaceous mud,—all traces of these organs should have been lost, had they ever existed.

We are compelled to conclude that Trilobites had not even membranaceous feet, and that the ventral surface was destitute of appendages. It is of course difficult to prove this. And almost all naturalists are disposed to allow them soft gills, attached to the under side. I do not see that the Trilobite had any need of appendages, further than what might be necessary as breathing organs. In this I have the concurrence of Prof. Wyville Thompson, who has given some thought to the affinities of the group. If gills existed at all, they were probably quite minute.

There is some reason to believe that, like its predecessor, the Annelide, the habit of the Trilobite was to gorge itself with the carbonaceous mud, and extract from it the nutritive portions. Such material has, indeed, been found in the straight intestinal canal of the Trilobite. Barrande has figured a specimen in which this viscus is preserved, a natural cast being taken of the interior by the sabulous matter swallowed by the animal.¹ What the nature of this sabulous matter was originally may be matter of conjecture; but it was solid enough to retain the stomach and intestine in a dilated form, while the surrounding matrix was solidified. It must, therefore, have consisted of a hard food, such, for instance, as the shells of Lingulæ, or, if the habit was carnivorous, of the contents of the bodies of the worms devoured,—or, lastly, of the silty mud among which the creatures lived. Against the former supposition we have strong reason to conclude, for Trilobites certainly possessed no hard jaws capable of comminuting shells or corallines, which we know existed during the same period. I see no likelihood of the carnivorous habit, and venture the latter suggestion. Mr. Spence Bate also thinks the mouth was contractile.

The only hard portion of the under side is the immoveable upper lip or labrum; and this may have been the instrument by which the food was scraped together. The absence of feet, and the presumed nature of the food would give me reason for believing that the Trilobite did not swim, as supposed by many authors, but crawled along the bottom. The shape was fitted for this; all Trilobites, whatever be their ornament on the upper side, present an even contour round the margin, which would apply itself to a flat surface accurately, while the under side was no doubt smooth and soft.² Probably, in many cases, the Trilobite lay half-buried in the silt, as is the frequent habit of the large *Limulus*, or King-crab.

¹ In the genus *Trinucleus*, vol. i, pl. 30, fig. 38, of the 'Système Silurien de Bohême,' par Joachim Barrande, 1852, Prague and Paris, vol. i. A magnificent and costly work, of which only the Trilobites are yet published.

² The analogy with *Chiton*, perceived by some of the old writers, is not altogether fanciful. At least, the habit must have been very similar, though of course there is no direct relation.

I am indebted to Mr. Spence Bate for some friendly criticisms of these views, and shall wait with interest for his promised memoir on the 'Homologies of the Trilobite, and its Habits.'

The general structure of the animal will be best perceived by referring to the woodcuts a little further on; and while there is, in the greater part of this structure, a sufficient resemblance to the ordinary Crustacea, there are one or two points in which the Trilobite differs from all other groups, and they happen to be obvious ones.

The curious so-called *facial suture*, a line of division which is only faintly indicated in the *Limulus*, and which has, perhaps, no other representative¹ in the whole Crustacean class, sufficiently distinguishes the Trilobite. It divides the head into two portions, an anterior one that bears the eye, and a posterior that covers the stomach. The latter segment is much larger than the former, and may be formed of several rings.

And then there is the "trilobation." Whatever tendency some of the higher Crustacea may show to this, and in whatever degree a few of the Trilobites may lose it, it is the conspicuous character of the whole order, and has, doubtless, an important meaning. *Limulus* also shows a trace of this trilobation; but it is accidental, rather than characteristic, in other groups.

I give here a copy of the original figure in the 'Memoirs of the Geol. Survey,' vol. ii, Part I, p. 334. It is not drawn from any particular Trilobite, but is a general expression of the structure.

And I have added one or two terms from Barrande's more complete figures.

FIG. 1.

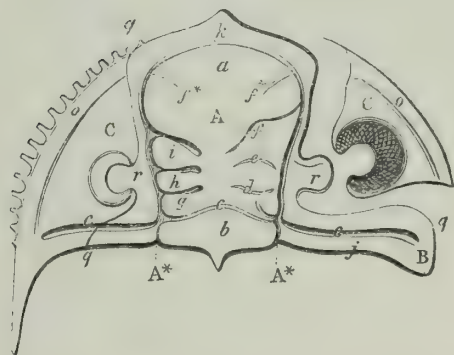
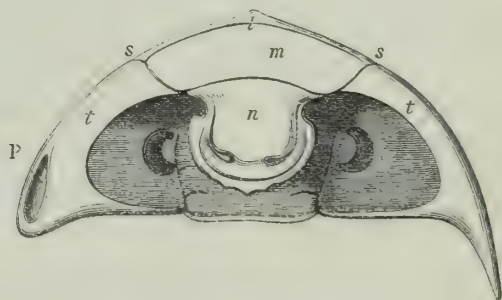


FIG. 2.



Beginning with the HEAD, or carapace (Fig. 1, upper side; Fig. 2, under side), we recognize the following portions:

GLABELLA (A), bounded by the axial furrows (A*), and including the neck-furrow (c);

¹ I am bound to state that Mr. S. Bate believes he has discovered the analogue of this suture on the under side of the crab and lobster; he finds it too in *Argulus*, &c. But his views are not yet fully published.

the basal furrows (d); middle or ocular furrow (e); upper or frontal furrow (f); with an occasional pair of frontal furrows (f^*).

These furrows bound and include the various lobes, designated thus: the frontal lobe (*a*); upper or third lobe (*i*); middle lobe (*h*); basal lobe (*g*); neck-lobe (*b*).

The sides or CHEEKS consist of a portion fixed to the glabella (B *j r k*) ; and separated from the free or moveable cheeks (o C) by the FACIAL SUTURE (*q q*). These moveable cheeks bear the EYES ; the fixed cheeks include the eye-lobe (*r*), the neck-furrow (*c*), and in some cases the posterior angles (B), often produced into spines.

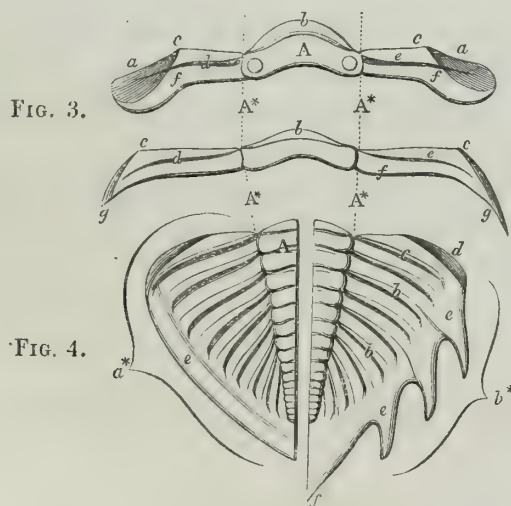
The posterior margin (j) is usually divided by the facial suture, which, in other cases, cuts the outer margin at q .

The front margin of the head is sometimes produced into a point (*k*), and on its under side (fig. 2) shows the **ROSTRAL SHIELD** (*n*), with its suture (*l*) (rostral suture); the inferior branches of the facial suture (*s s*), the incurved under margin (*t*), the **LABRUM** or **EPISTOMA**¹ (*n*), and sometimes a cavity (P) for the reception of the ends of the pleuræ in rolling up.

Each THORAX-RING (fig. 3), in like manner, consists of the AXIS (A), with its articular portion (*b*), divided by the axial furrows (A*) from the side-lobes or pleuræ. These last, whatever be their nature, are in one piece with the axis, never articulated with it.

The PLEURÆ consist of a posterior portion (*f*), a fulcral or anterior portion (*e*), separated by the deep pleural groove (*d*). At *c* the fulcral points are seen, beyond which in most genera the segment is faceted (*a a*), for rolling up. These facets (*a a*) are always smooth, and slide under the preceding joint in the act of rolling.

Sometimes the terminal portion is produced into spines, (g, g) .



The TAIL, or PYGIDIUM (fig. 4), consists also of an AXIS (A), with its articular portion, as in the thorax; the LIMB or lateral portion is either entire, as at (a^*), or shows its component

¹ The exact nature of this piece is not quite certain. I use '*labrum*' in the descriptions.

pleuræ as at (*b**). The furrows (*b b*) correspond to the pleural grooves of the thoracic joints, and the finer intermediate lines mark the sutures between the several segments of which the tail is compounded. The anterior groove (*A*) is generally the strongest. The margin (*e*) is mostly smooth and even, and often concave. At (*d*) the facet is seen on the front edge; (*f*) is the mucro, either short or prolonged into a spine, and often absent altogether.

These are not all the points of structure visible on the crust of the Trilobite. But it is desirable not to multiply terms. I prefer the ordinary appellations *head* and *tail* to the more correct designations, *carapace* and *post-abdomen*. The *axis* is a convenient and well understood term for the middle portion, and is better than *tergum*; and the terms *side-lobes*, *limb*, or *lateral portions* of the tail; *free* and *fixed cheeks*, &c. to the head, are sufficiently intelligible and well known to render it unnecessary to give the more technical designations "*epimera*," &c., even if we were quite sure of the correctness of all of these.

It is indeed quite possible that the free cheeks, with the connecting portion in front, constitute the first or ocular ring, and the rostral shield would form the sternal portion of the same ring. But there is not absolute certainty of this, and some naturalists disbelieve it. The rostral shield *may* be the only representative of a small anterior ring, and in that case we should be only inventing prematurely a new term, in deciding to call the first segment, as McCoy has done, the ocular ring. Nor would it be so convenient in description.

Again, the glabella certainly covers the region of the stomach, and the glabella-furrows doubtless mark the attachment of the muscles of the several segments proper to the head, and covered by the expanded carapace. There are always three (and in *Ogygia* and some other genera, four) of these lateral furrows; and if they indicate the number of segments combined in the carapace, instead of the number of thorax-segments covered by it, we should still be at a loss whether to call the neck-segment, which is always combined with the carapace, the fifth or sixth segment in the general plan. But by adhering to the terms "free cheeks," "facial" and "rostral sutures," "rostral shield," "glabella-furrows," "neck-segment," "tail," &c., while there is no false assumption in the terms, so neither are they too far removed from a scientific and technical nomenclature to be useful.

It may before long be practicable to adopt a more complete terminology. But in these descriptions I adhere to Dalman's formula, modernized a little to adapt it to our more advanced knowledge of the group.

FAMILY—PHACOPIDÆ. *Emmerich, Corda, Salter, &c.*

Eyes largely faceted, the cornea convex over each facet, forming a granulated, not a smooth eye. Facial suture ending posteriorly on the outer margin of the cheek. Thorax with eleven rings. Includes at present only one genus, PHACOPS. (*Sub-genera*.—TRIMEROCEPHALUS, PHACOPS, ACASTE, CHASMOPS, ODONTOCHILE or DALMANIA, CRYPHÆUS.)

Beginning, then, with the family of the Phacopidæ, as being on the whole the most typical and highly organized, I may remark that there is less difference between the various groups into which this natural family is divisible than between the various members of the neighbouring families. So much is this the case, that palæontologists have as yet been generally unwilling to break up this group into genera, or to consider its divisions as more than sub-genera of the great genus *Phacops*. Or, if they divided it, they have been obliged to include a greater variety of forms in some of the divisions than in others: *Dalmania*, or *Dalmanites*, is an example of this. It was intended by its author, Emmerich, to include only the broad expanded forms of the genus; but M. Barrande, whose authority has much weight, has widened its meaning so as to include all the forms which have distinct lobes to the glabella; thus including in *Dalmanites* both convex and flat forms, in fact, four-fifths of all the species; while the original term, *Phacops*, includes the rest.

Prof. Goldfuss had previously taken the same view, but applied the term *Acaste* to the larger group, leaving only the species with inflated lobeless glabella in *Phacops*. This view is a consistent one, for Dr. Emmerich, in founding his genus, gave these last as the type of it. But in the 'Neues Jahrbuch' for 1845, Dr. Emmerich objected to this plan, preferring to unite all the more compact and convex forms in *Phacops*, whether with lobed or lobeless glabella, separating only the more expanded forms, as *Dalmania*, a term which, though in general use, had unfortunately been in previous employ for a group of insects. Prof. Burmeister did not attempt to divide the group at all, and Prof. McCoy included all under *Phacops*, while he recognized truly most of the subgeneric groups.

It will be seen that there is a considerable diversity of opinion as to the value of the subdivisions; and this arises, I think, from the fact before noticed, that the various sub-genera in this, the highest group, differ only by characters of proportion and degree of development of the different parts, while the main features of the group remain constant.

The great characters pointed out first by Quenstedt, viz., that the Phacopidæ have eleven, and only eleven, rings to the thorax, while other groups are variable in this respect, and that all have the strongly faceted eyes, have in the eyes of naturalists overruled the minor distinctions, and disposed them to undervalue the real differences of proportion which exist. In the Decades of the Geological Survey, I have endeavoured to do justice to all the above distinguished authors; and, retaining the name *Phacops* for the whole, pointed out the several natural sub-genera. I believe still we shall best consult the convenience of students by retaining the common name.

No doubt, if we had the living animal, we should attach greater value to what in the fossil appear subordinate characters. The degree of development of the eye, for instance, should surely be a point of much importance in any group. The expanded form and large size of one division, contrasted with the contracted dimensions and compact habit of another, is certainly of consequence, and may well afford generic characters.

And when we find the caudal margin in one form even and compact, while another has

the component pleuræ free at their extremities, simulating the character of neighbouring genera, we cannot doubt that we are looking at a group of genera combined by common characters into a natural family.

If I express my own opinion, that the sub-generic groups here given are natural genera in the ordinary sense of the word, and will be hereafter used as such—while for convenience sake, and till the sub-divisions are completely established, we adopt the common term, it will perhaps be all that in the present state of our knowledge is advisable.

Genus—PHACOPS, *Emmerich*. Characters those of the family.

Range. Lowest Silurian—to Uppermost Devonian.

Subgenus I. TRIMEROCEPHALUS, *M'Coy*, 'Annals Nat. Hist.,' 2nd series, vol. iv, 1849.

FIG. 5.



P. (Trimeroc.) Volborthi,
Barr., Wenlock rocks of
Bohemia.

Form compact, glabella inflated and expanded in front; the lobes, except the basal ones, obscure. Eyes small, of few large lenses (often lost by abrasion). Head-angles not spinous. Pleuræ all rounded. Tail small, of few segments, with even border, and not at all produced. Ex. *P. lævis*, *P. Volborthi*, *P. micromma*, &c.

Range. Upper Silurian—to Upper Devonian.

Subgenus II. PHACOPS, *Emmerich*, 1845.

Form compact, glabella inflated and expanded in front, the two front pairs of furrows obscure. Eyes large and well developed, of numerous lenses. Head-angles not spinous. Pleuræ all rounded. Tail moderate, of few (often coalesced) segments, with an even border, never produced.

Range. Upper Silurian—to Uppermost Devonian.

Subgenus III. ACASTE, *Goldfuss*, 1845.

Form compact, or at least not expanded. Glabella not inflated, nor much expanded in front; all the furrows distinct. Eyes well developed, of numerous lenses. Head-angles

spinous. Pleuræ rounded or truncate, not produced into spines. Tail moderate, of less than eleven segments, with an even border, but often mucronate.

Range. Lower and Upper Silurian.

Subgenus IV. CHASMOPS, *McCoy*, 1849.

Form rather large and depressed. Glabella greatly expanded in front, the lobes unequal, the hinder ones being contracted, and almost obsolete; the front pair greatly expanded, and overlapping the others. Head-angles spinous. Pleuræ truncate. Tail large, of few or many segments, not dentate, and seldom mucronate.

Subgenus V. ODONTOCHILE, *Corda*, 1847. (DALMANIA, *Emmerich*, 1845.)

Form large, depressed. Glabella depressed, not much expanded in front; all the lobes distinct, the front ones not enlarged at the expense of the others. Head-angles long-spined. Pleuræ truncate, and the hinder ones often produced. Tail large, of more than eleven segments, with an even border,—often mucronate.

Range.—Lower Silurian, rare; Upper Silurian, common.

Subgenus VI. CRYPHÆUS, *Green*, 1837.

Form of moderate size, depressed. Glabella depressed, not much expanded in front; all the lobes distinct, the front ones not greatly enlarged. Head-angles long-spined. Pleuræ truncate, and the hinder ones often produced, into spines. Tail large, of many segments; the margin spinose.

I believe there are more subgenera of *Phacops* to be discovered and described yet. For instance, there is probably more than one included here under *Trimerocephalus*, and there is a South African form of *Cryphæus*, which has the characters of *Acaste* in the compact habit and convex tail. All the other subgenera also contain species which it would be difficult to assign rightly to one or the other.

It will be observed that we have here a wide range of characters, and in regular gradation, from the most expanded, flattened forms, with glabella deeply lobed, and the segments of the large tail almost free, to the most compact and rounded form, with the caudal extremity reduced in size, of even contour, and with the segments most coalesced. We begin with the subgenus *Trimerocephalus*.

Subgenus—TRIMEROCEPHALUS, as above.

1. PHACOPS (TRIMEROCEPHALUS) LÆVIS, *Münst.*, sp. Pl. I, figs. 5, 6, 7.

ASAPHUS or TRINUCLEUS, *Sow.* Geol. Trans., 2nd series, vol. v, pl. 57, fig. 30, 1840.

TRINUCLEUS LÆVIS, *Münster.* Beiträge, Heft 5, t. x, fig. 6, 1842.

CALYMENE LÆVIS, *Phillips.* Palæozoic Fossils, pl. 55, fig. 250 (1841).

TRIMEROCEPHALUS LÆVIS, *McCoy.* Ann. Nat. Hist., vol. iv, p. 404, woodcut, 1849.

— — *Ibid.* Synopsis Woodw. Mus., 1851, p. 178.

Diagnosis.—*P. (Trim.) late ovatus, lævis, glabellâ latissimâ, brevi, genas subsphæricas trigonas impendente, lobis basalibus minutis distinctis. Axis thoracis angustus, fulcro pleurarum axin approximato, sulcoque brevi. Cauda latissima brevis, axi longo 5-annulato, lateribus 4-sulcosis, margine nullo.*

This was first figured in England from very imperfect specimens, which came from the only English locality yet known, viz., the Knowl Hill, near Newton Bushel. They are mostly distorted, and, as first noticed by Mr. Pengelly, the head is usually disjoined from the body and inverted, as if the animal had habitually kept it bent under, and been preserved in the slate in that position. In that condition it is often difficult to distinguish the parts correctly.

But the number of specimens already collected enable us to restore the animal pretty completely; and there is not much doubt that it is identified rightly with the *Trinucleus lævis* of Münster.¹ Both Mr. Sowerby and Professor McCoy have recognized it for this fossil, and Dr. Sandberger has quoted it as a synonym, only he mixes up two or three other species with it,—among others the (*Calymene*) *Phacops lævis* of Münster.

It is clear, however, that it is distinct from the small trilobite originally named *Calymene lævis* by Münster, and next described; as the following description will show.

And should it prove that the fossil called *Cal. lævis* by Münster is a real species, we should have to find a new name for this. Dr. Sandberger wishes to connect it with the *Phacops cryptophthalmus* of Emmerich, a fossil also occurring in the same Devonian formation. But though much disposed to believe that our fossil has true but superficial eyes, which are not easily preserved, I cannot think that this is a true identification. The eye of *P. cryptophthalmus* is very much more distinct, and I have figured what I believe to be that species, with the eye, a little further on. *P. cryptophthalmus*, too, is described and figured by Dr. Sandberger as having a larger semicircular tail, while ours has a very short one. I may now describe the Knowl Hill fossil.

¹ From the red shales of Guttendorf. The head only is figured by Münster.

General form broad-oval, not very convex. Length occasionally $1\frac{3}{4}$ inch. Head smooth, semicircular, deeply trilobed, the lateral angles rounded. Glabella very broad in front, spherical-triangular, occupying much more than one third the width of the head; convex, but not gibbous, and overhanging the front; neck-furrow strong, basal lobe distinct, and with two lateral tubercles, the rest of the lobes obsolete. Cheeks triangular, evenly convex, with a narrow margin, which is strong at the rounded angles, and lost in front of the glabella; the neck-furrow strong. (Eyes absent in our English specimens, but probably present in perfect individuals.)

Thorax of eleven segments, with convex narrow axis and rounded pleuræ; the segments of the axis tuberculate at the sides; the pleuræ not much bent back, rounded at the end, the groove narrow and short, the fulcrum placed at less than half way out from the axis; facet rather large. Tail short, transverse, flattened, arched in front, straighter behind, about as long as the axis of the thorax is broad, and more than twice as wide as long, of few joints, the axis conical, and reaching nearly to the margin, blunt at the tip, and with four or five rings. The sides wide, with not above four furrows, which do not reach the margin, and are faintly interlined with other furrows.

Localities.—UPPER DEVONIAN. Knowl Hill, Newton Bushell; specimens figured from Mr. Pengelly's cabinet (figs. 5, 6), and Mr. Vicary's (fig. 7). I distrust the other South Devon localities given in the "Pal. Foss.," viz., Mudstone Bay and Durlstone. But it is probable the species occurs at Brushford, North Devon, as quoted by Professor Phillips.

P. CRYPTOPHTHALMUS, *Emmerich?* Pl. I, fig. 8.

PHACOPS CRYPTOPHTHALMUS, *Emmr.*, in Leonhard und Bronn's Jahrbuch., 1845, pp. 27, 40, &c.

— — *Roemer. Palæontographica*, vol. iii, pl. vi, p. 14 (bad figure), 1854.

— — *Sandberger. Verst. Rheinisch. Schicht. Syst.*, t. i, fig. 6 (exclude his synonyms, as he includes several species, among others, the *P. lævis* figured above), 1850.

PHACOPS LIMBATUS, *Richter?* (*vide* Sandberger).

"*P. capite semiorbiculari, lateribus frontis rectilineis, ad angulum acutum convergentibus. Annulus fere rectilineus. Oculi parum evexi. Thorax latus. Pygidium breve obrotundatum, ex articulis 8, pseudopleuris 5, compositum. Superficies subtilissimè granulata.*" Sandberger.

I suppose this to be the species given in Sandberger's beautiful plates. The character, "eyes but little prominent," well agrees with this species. He figures the eyes as lunate, and with fewer lenses than our Newton specimen. But the shape of the glabella is the same, and I do not see that there is much room for doubt.

Locality.—UPPER DEVONIAN: Newton Bushell (Mus. P. Geology).

Subgenus—PHACOPS, as above.2. P. (PHACOPS) GRANULATUS, *Münster*. Pl. I, figs. 1—4.

CALYMENE, sp., *Sow.* Geol. Trans., 2nd series, vol. v, pl. 54, figs. 23, 24, 1840.

— GRANULATA, *Münst.* Beitr., Heft 5, t. v, fig. 3, 1842.

— LÆVIS, *Id.* Ib., t. v, fig. 4.

— GRANULATA, *Phillips.* Pal. Foss., fig. 248 (exclude figs. *m, n, o, p*), 1841.

PORTLOCKIA GRANULATA, *M'Coy.* Synopsis Woodw. Foss., p. 177, 1851.

Not an inch long. General form broad-oval. Head semicircular, very convex, covered with granules, the sides much bent downward. Glabella fully half the width of the head, very tumid, slightly pointed in front and overhanging the front margin. Its greatest width exceeds its length, even including the neck-segment. Sides converging at an angle of 90° , the base narrow; a small basal lobe, with a tubercle on each side, but no trace of upper furrows. Cheeks moderate, with a strong border. Eyes large, prominent, with few, about thirty-six lenses, five in a row. (*M'Coy.*)

Thorax ?—

Tail semicircular, small, convex, with a smooth, declining, distinct margin, and prominent conical axis, reaching rather more than two thirds down, tapering and almost pointed at the extreme end, which fades into the limb, marked with six or seven rings, obscure at the tip. The lateral lobes have five or six strongly duplicate furrows.

There seems no good reason for separating *Münster's C. lævis* from the above. It is merely a decorticated specimen, the surface-granulation consequently absent. The tail, as figured by *Münster*, has too many ribs, and too long an axis, but is otherwise like ours; and *Münster's* figures are not fully to be trusted.

Locality.—UPPER DEVONIAN. Petherwin, Cornwall. (Our best specimen, fig. 1, is from Mr. Pengelly's cabinet; the others from the Mus. P. Geology.)

P. (PHACOPS) LATIFRONS, *Bronn.* Pl. I, figs. 9—16.

CALYMENE LATIFRONS, and C. SCHLOTHEIMII, *Bronn.*, in Leonhard's Zeitschr. f. d. Miner., 317, t. ii, figs. 1—8, 1825.

CALYMENE LATIFRONS, *Bronn.* Lethæa. Geogn., t. ix, fig. 4, 1835.

— TUBERCULATA, *Murch.* Sil. Syst., pl. xiv, fig. 4, 1837.

— LATREILLII, *Steininger.* Mémoires Soc. Géol. France, vol. i, pl. ii, 1834.

— SCHLOTHEIMII, C. BRONGNIARTII. Ibid., p. 350, 351.

— LATREILLII, *Phillips.* Pal. Foss., fig. 249, 1841.

— ACCIPITRINA. Ibid., p. 128.

PORTLOCKIA LATIFRONS, *M'Coy.* Synops. Woodw. Mus., 1851, p. 177.

PHACOPS LATIFRONS, *Sandberger.* Verstein. Rheinisch. Schichten-Syst. Nassau, t. i, fig. 7, 1850.

— — *Roemer.* Palæontographica, vol. iii, t. ix, figs. 24, 25, 1854-1855.

General form.—A large species; foreign specimens often attaining a length of $2\frac{1}{2}$ inches, and some of our English fragments indicate a still larger size.

The head occupies fully one third of the whole length, and is rather more than a semicircle, and very convex. The inflated glabella occupies more than half the width, taking its measure at the wide front, from which the straight sides converge at an angle of 85° . It is about as wide as its whole length, including the neck-lobe. The glabella is very much rounded in front, and scarcely overhangs the narrow linear margin. Its whole surface is covered with large, coarse tubercles, at equal distances, scarcely more than their diameter apart. There are but slight traces of the upper furrows; but the tumid glabella is strongly separated from and overhangs the linear basal lobe, which has not distinct lateral tubercles, but in the internal cast shows deep pits on either side, above and below the lobe. The neck-segment is strong and broad, wider than the basal lobe. The neck-furrow is continued round the smooth cheek, and separates a broad, strong margin, leaving a subtrigonal space, much of it occupied by the great eye, which varies from half to more than half the length of the cheek, and is placed rather behind the middle of it. The eye, from the depression of the upper eye-lobe, is subhemispheric, not greatly curved, but strongly convex exteriorly, and covered by about fifty-four strong, prominent large lenses,—in rows shortening towards either side; about five in one of the central vertical rows. Externally the lenses are very convex.

Foreign specimens show us that the cornea of this species is very thick, and rises into ridges between the lenses; and it apparently thickens by age internally. At least old specimens (fig. 9) have the substance much thicker, as shown by the great projection of the casts of the supporting cups (fig. 12*), which of course are the spaces occupied by the soft substance which lay underneath the lenses.

In some instances, probably in younger individuals, the projection of the cups is considerably less (fig. 13). In others again, the cups project so little, and the cornea is so thin, that there is little difference of level between the ridges and the cups (fig. 11*a*). I do not think these differences of proportion, nor even the varying numbers of the lenses in different individuals, at all tend to constitute distinct species. Steinger gives us 46 to 50 lenses in one variety, 87 in another, and 130 (probably for the two eyes) in a third. But he has not pointed out any clear distinctions in the species to accompany these differences in the eye. A specimen of *C. bufo*, Green, which is a closely allied form, and may possibly be only an extreme variety of our species, has 66 lenses in each eye.

The eye is elevated, the lentiferous surface not sunk in a furrow, but standing prominently out from the cheek, and overhanging its own base (fig. 11). Head-angles rounded. Obscure traces of the facial suture occur below the eye, but practically they are soldered, and the head does not part at the sutures at all.

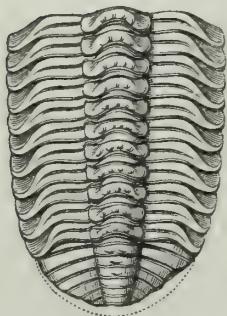
Thorax (in German and Spanish specimens) with the pleuræ much bent down, so

* These cups in the cast of a Trilobite's eye occupy the place of the vitreous body, according to Dr. Burmeister's explanation of the eye-structure. 'Organiz. of Trilobites,' Ray Soc. edit., pl. vi, fig. 4*d*.

that the axis looks nearly as wide as the pleuræ. It is not in reality nearly so broad. The surface is coarsely granulated, as is that of the tail, when the crust is preserved.

There is a perfect body,* with eleven rings, in Mr. Vicary's cabinet, of which a woodcut is here given. The axis is convex, semi-cylindric, tubercular, very slightly nodular on the sides, and little more than half as broad as the pleuræ. These are very convex, and as steeply bent down as in *Calymene*; the fulcrum is placed at about one third out, and as far from the axis in the hinder as the front rings. The pleural groove is not very deep, and does not reach the long facets. The ends of the pleuræ are recurved and rounded.

Fig. 6.



Body and tail of *Phacops latifrons*; Newton Bushell.

Tail in our specimens (figs. 14, 15,) wide, more than semicircular, arched in front, and very convex, with the axis quite elevated, and separated by broad furrows from the convex limb. A few tubercles show on the ribs of the axis. It projects in front, slowly tapers to a rounded end at one sixth from the margin, and is strongly annulated by seven or eight rings (ten in some German specimens) while the convex sides slope quickly down, and have five or six strong ribs, straight, or but little curved, and all but reaching the indistinct margin. There is no flat border. The axis varies in breadth, but is never so much as one third the whole width, usually one fourth. Incurved under margin very convex.

Localities.—LOWER DEVONIAN. Hope and Barton, South Devon; near Liskeard and Totnes, in slates with *Pleurodictyum problematicum*. UPPER DEVONIAN (Petherwin Group)? Newton Bushell. UPPERMOST DEVONIAN (Barnstaple Group). Croyde, Barnstaple, and the neighbourhood; Brushford, Pilton, &c., abundant; Yealm Bridge, north of Launceston (Pattison and Salter).

Foreign localities.—Rhenish Prussia, Belgium, France, Russia, (*P. bufo* takes its place in North America); also the Andes, South America (Mus. Geol. Soc.).

Var. Pl. I, fig. 16.

I figure as a variety the wide pygidium found at Newton Bushell, which differs from the ordinary forms of *P. latifrons*, by the narrower proportion of its more depressed axis to the sides,—little more than one fourth, and in having the six side ribs more direct than usual. It can only be a variety, but the aspect is different to that of the common form.

Locality.—UPPER DEVONIAN.* Newton Bushell.

* I consider the upper quarries of Newton Bushell as the equivalent of the Petherwin beds. This subject requires minute examination, and will be determined chiefly by the labours of local geologists. The upper limestones are clearly not of the same age as the great Plymouth limestone, but nevertheless, they contain a good many of its fossils.

P. (Phacops) STOKESII, *Milne-Edw.* Pl. II, fig. 1—6.

ASAPHUS MACROPHthalmus, *Brongniart.* Crustacés Fossiles, pl. i, fig. 5 (*not* fig. 4), 1822.

CALYMENE MACROPHthalmA, *Buckland.* Bridgw. Treatise, pl. lxiv, fig. 4 (*not* fig. 5), 1836. *Murchison*, Silur. System, pl. xiv, fig. 2, 1837.

— STOKESII, *Milne-Edwards.* Crustacés, 3, 324, 1840.

PORTLOCKIA SUBLEVIS, *M'Coy.* Sil. Foss. Ireland, pl. iv, fig. 13, 1846.

PHACOPS STOKESII, *Salter.* Memoirs Geol. Survey, vol. ii, pt. 1, pl. 5, fig. 1, 1848. Quart. Geol. Journal, vol. vii, pl. ix, fig. 2, 1850.

— — *M'Coy.* Synopsis Woodw. Mus., p. 163, 1851.

— — *Salter.* Siluria, 2nd edit., pl. 18, fig. 6, 1859.

P. (Phacops) 1—2 uncias longus, ovatus, granulatus. Glabella parum inflata, frontem impendens, sphaerico-trigona, lobis basalibus rotundatis, reliquis omnino (etiam intus) obscuris. Oculi magni, insuper depressi. Thorax axe angusto. Cauda brevis semicircularis, convexiuscula, immarginata, axi depresso 5-annulato, lateribus 4—5-sulcatis, sulcis abbreviatis obscuris.

This is a very common Upper and Middle Silurian fossil, but is never found in Lower Silurian Rocks. Yet it is but imperfectly known, being generally in fragments. And it has been moreover a troublesome one to the palæontologist, owing to the original mistake of Brongniart, in confounding it with the true *macrophthalma*. And, until lately, specimens of the more common *P. Musheni*, our next figured species, were constantly mistaken for it. I believe the above synonyms may all be trusted, and I do not cite the more doubtful ones.

The species is rather a small one, seldom exceeding an inch or an inch and a half in length, and is obtusely ovate and very convex. The head occupies less than a third and more than a fourth of the whole length, and is semicircular, and wider than the thorax; the glabella is an equilateral spherical triangle, overhanging the front and the eyes, and much narrowed behind, where the basal lobes are distinct enough as small tubercles on each side of a linear lobe. This is overhung by the inflated upper lobes, which are confluent, and show only very obscure traces of any of the upper furrows, even on the inner cast, where they are strongest. The median furrows are short and curved, the upper strongly bent midway, as in many species of the subgenus *Phacops*. Surface of glabella covered with a fine granulation.

The cheeks are triangular, with a strong, continuous, marginal furrow. The eyes large, much depressed above, and with the lentiferous surface gently curved, of numerous lenses, and so placed that the forward end nearly touches the glabella, while the base is widely distant, and does not moreover reach the sharp neck-furrow.

The body has a convex axis, narrower than the pleuræ, which have a deep sharp groove for two thirds their length, and are steeply curved down beyond the fulcrum, the latter being placed less than half-way out in the front rings, and at one third behind.

The tail is semicircular, gently convex, but with the axis depressed and flattened; it tapers slowly, has a blunt apex, and is marked by five or six segments. The side-lobes have four or five abbreviated narrow furrows; the upper ones are interlined, but all are inconspicuous.

Our larger figure (fig. 6) is from a doubtful locality in the Wenlock Rocks, but is certainly British. It shows the internal cast of the head sufficiently well. The species grows occasionally to a rather large size, as may be seen by this specimen, and others in the cabinet of Mr. Hollier, of Dudley. But usually the specimens are not larger than our other figures. *P. sublævis* of M'Coy is a very obscure drawing, but the original specimens do not differ from *P. Stokesii*.

Localities and Geol. Range.—LLANDOVERY ROCK, Galway; Ayrshire; Haverfordwest, Pembrokeshire. MAY HILL SANDSTONE, of Tortworth; May Hill; Malvern; Shropshire. WENLOCK ROCKS; Abberley; Malvern; Dudley; Wallsall; North and South Wales; Dingle, West of Ireland; Peebleshire. LUDLOW ROCKS; near Leintwardine, Shropshire; Pentland Hills, Edinburgh.

P. (PHACOPS) NUDUS, n. sp. Pl. VI, figs. 19, 20.

P. parvus, convexus, omnino P. Stokesii simillimus, nisi genis profunde marginatis, oculorum lentibus paucis, caudâ rotundiore, lateribus inflatis, costis distinctioribus.

It is difficult to define the fragments of this species, otherwise than by comparing the parts with the better known and more perfect *P. Stokesii*, from which the species, a really distinct one, differs in the following characters—the general form and the shape of the glabella being extremely like in both cases.

The cheeks are larger, more rounded, and less convex, rather suddenly raised, and with a tumid space between them and the glabella (*d*). The lenses are far less numerous, and have granules in the interspaces (*f*). The tail (fig. 20) is more oblong than a true semicircle, transverse, blunt, and is more depressed. The axis is short, with an obtuse flattened tip, and has six rings; the lateral lobes tumid, with four arched furrows (including the uppermost one), and a very obscure fifth furrow. They do not nearly reach the margin, and are faintly interlined. The tumid sides, being rather strongly divided from the flattened axis, give a peculiar character to the tail, very different from that of *P. Stokesii*.

This new form has unexpectedly turned up in the collections made by the Irish Survey in the wild district of the Dingle Peninsula. In the mountain of Cahirconree, among slates of decidedly Upper Silurian date, occur some limestones, of whose age we are not so clear, but containing the present species, which belongs to an Upper, and not a Lower Silurian group. I have not much hesitation in referring them to the Wenlock, or

more probably the May Hill, formation. The *Illænus Barriensis*, *Spirifer plicatellus*, and other Upper Silurian species, occur with them.

Locality.—WENLOCK or MAY HILL group. Cahirconree Mountain, west side, Dingle. [Mus. Irish Industry, B. 242, 243.]

P. (PHACOPS) MUSHENI, n. sp. Pl. II, figs. 7—12.

P. parvulus, vix $\frac{3}{4}$ -unciæ longus, ovatus, lævis. Glabella oblonga, haud inflata, superne urceolata, postice contracta, lobis basalibus profunde scriptis bituberculatis, reliquis connatis lineisque angustis modo sejunctis; sulci mediani breves, curvi; superiores fracti. Lobus frontalis transversus oblongus. Thorax axe convexo ut pleuris lato, his lentè recurvis fulcro prope axin posito, sulcoque pleurali angusto distincto brevi. Cauda semiovalis convexa immarginata, axe prominulo distincto pauci-annulato, lateribus 3—4-sulcatis abbreviatis angustiori.

A much smaller species than the true *P. Stokesii*, with which it has been very generally confounded. Nevertheless it differs by several important particulars, the chief of which is that the shape of the head is long instead of broad, and the glabella decidedly oblong instead of broad-triangular. The other portions, body and tail,—also differ; the axis of the body is broader, and that of the tail much more prominent, while the tail itself is of a longer shape, less transverse.

The length is seldom more than three fourths of an inch. The head in good specimens is half a broad oval (that of *P. Stokesii* being a semicircle). The glabella is much more than one third the whole width, oblong, only rather broader above than at the eyes, and is urceolate, the sides bulging out between the eyes, and then contracted for the hinder portion. The glabella is not at all inflated, nor does the front overhang in any sense, and the facial suture is not even quite marginal in front.

The eyes are fully half the length of the glabella, and very large and convex, not depressed above, about as deep as they are broad, and containing nearly 130 lenses. These have no visible spaces between them. The eyes are not very prominent, and on a side-view appear sunk, especially towards the front, into the cheek. They vary a little in size and prominence, but not very much so.

The body has a rather convex axis, which is as broad as the sides, or nearly so. The pleuræ are curved down gently at the *fulcrum*, which is at about one third anteriorly and less behind. The pleural groove is narrow, and reaches but little more than half-way along the pleuræ.

The tail is longer than semicircular, very convex, smooth, with a prominent axis (not flattened as in *P. Stokesii*), and reaching fully four fifths the length. It is long, conical, ringed above, and smooth towards the bluntish point; the sides are smooth, the three or four faint lateral furrows not reaching half-way over the convex limb, even in the upper portion,

and being quite obsolete in the lower. Only the upper ones are interlined. There is no marginal flattened space, nor any concavity; the tail is gently convex to the very edge.

Locality. *Wenlock Shale and Limestone.*—Malvern, abundant in Wenlock Shale; Dudley. It has not yet been found in other localities.

Subgenus—ACASTE.

PHACOPS (ACASTE) DOWNINGIÆ, *Murch.* Pl. II, figs. 17—36.

CALYMENE MACROPHTHALMA, *Brongniart.* Crust. Foss., pl. i, fig. 4 (*not* fig. 5), 1822.

— — — *Buckland.* Bridgwater Treatise, pl. lxiv, fig. 5 (*not* fig. 4), 1836.

— DOWNINGIÆ, *Murchison.* Silurian System, pl. xiv, fig. 3, 1837.

— — — *Milne-Edwards.* Crust., iii, 324, 1840.

ASAPHUS SUBCAUDATUS and A. CAWDORI, *Murchison.* Sil. System, pl. vii, figs. 9, 10.

ACASTE DOWNINGIÆ, *Goldfuss.* Syst. Uebersicht der Trilob., Neues Jahrb., 563, 1843.

PHACOPS MACROPHTHALMA, *Burmeister.* Organiz. der Trilob., 139, 140, 1843, ed. 2 (Ray Society), 1846, p. 92.

— DOWNINGIÆ, *Emmerich.* Neues Jahrb., 1845, p. 40, pl. i, fig. 2 (*icon mala*).

— — — Translated in Taylor's Scientific Memoirs, 1845, vol. iv, pl. iv, fig. 2.

— — — *Salter.* Memoirs Geol. Survey, June, 1848, vol. ii, pt. i, p. 336, pl. v, figs. 2—4; Decade vii (1853), pl. i.

— — — *M'Coy.* Synopsis Pal. Foss. Woodw. Mus., 160, 1851.

— — — *Murchison.* Siluria, 2nd edit., pl. 18, figs. 2—5, 1859.

P. vix biuncialis, alutaceus, margini frontali capitis angulato. Glabella depressa subparallela, sulcis utrinque tribus distinctis, lobo basali lineari, secundo ovali, superiori transverso, sulco antico ascendente sinuato; lobis omnibus planis, fere ad medium glabellæ, spatio angusto interjecto, extensis; cervice elevato. Oculi modici. Cauda subtrigona, marginata, apice angulato; axi convexo costato, costis 5 distinctis prædito; lateribus 5-costatis, costis duplicatis.

If I have given a lengthy set of synonyms, they do not represent a moiety of the works in which this very common fossil is noticed. It is one of the really abundant Upper Silurian species, being moreover one of the few trilobites which are common in the Ludlow rocks, as well as in Wenlock strata. No trilobite is more frequent on the Dudley slabs; but it is rare to find it in the underlying shale. I have seen it from many parts of Britain, but do not know that it has ever been described from foreign localities; nevertheless it does occur in the true Upper Ludlow rocks of Nova Scotia, as we learn from the collections brought to the International Exhibition by the Rev. D. Honeyman, in 1862.

An inch and a half long; general form long, ovate, broader in front, the axis following the same lines, and regularly tapering towards the tail. The surface is moderately convex,

the axis raised above the sides, not separated by deep furrows except in the head, and more convex in the thorax than in the head or tail.

The head is less than a semicircle, though just twice as long as broad; the general outline rather triangular, from an indentation in the outer margin on each side of the glabella; the front is not produced, but angular. The glabella occupies more than one third the width of the head in front. It has nearly straight, parallel sides, and rises considerably above the cheeks, but is depressed rather than convex, especially the forehead-lobe, which slopes gradually to the narrow marginate front. Neck-lobe strong, broader than the first basal lobes, which are transverse and linear; the middle pair are broader than these, and oval. The lower furrow bends downwards, and reaches the side of the glabella; the middle one is abbreviated, and curves the reverse way. Upper lateral lobe transverse, scarcely triangular, bounded above by a sigmoid furrow, which runs obliquely out above the eye.

All the furrows stretch equally towards the middle of the glabella, leaving but a narrow space between their ends; between the upper pair a short longitudinal depression occurs. The lobes are not swelled between the furrows, but the surface is even, and the furrows shallow (they are, however, sharply defined on the internal cast), the neck and basal furrows strong; the upper ones fainter.

The cheeks are steeply bent down, their outer margin not distinguished by any furrow, and they slope gradually from the eye, without any ridge or groove, beneath the latter; the neck-furrow is continued almost to the angle, which is rounded off, and has a tubercle only in place of a spine. The facial suture cuts the outer margin in a curved line opposite the base of the eye; on the under surface of the head the suture cuts the margin further backward (fig. *b*). In front of the eye it runs along the axal furrow and round the glabella just outside the marginal furrow. It is thus what is called *intramarginal*.

Eyes moderately large, in some specimens (figs. 18, 25, 26, 30) much larger than others; and they rise occasionally to the level of the glabella, but are generally lower. The eye is not very prominent; it is placed half-way up the cheek, near to the upper glabella-lobes, and occupying their length; eye-lobe with a raised outer margin; lenticular surface broad, with about 155 lenses in the eye, each vertical row containing eight. The cornea is convex over the lenses, and the intermediate flattened spaces are finely granular, the granules forming a rough hexagonal network toward the base of the eye; the lenses are nearly their own diameter apart, but this varies much in different individuals, the space being often much less. (Fig. 36, *d*, *e*.)

On the under side of the head the incurved front portion, or *hypostome*, as in all the genus, is continuous across; it is broad (fig. 36, *b*) and granular, like the upper surface. The labrum is also granulate; it is subquadrate, broadest at base, regularly and strongly convex; a faint concentric furrow runs round its sides and tip, just indicating a narrow margin more flattened than the other parts; there are no lateral furrows, but high up on each side is a small tubercle. The tip is obtusely truncate, with no visible serratures. The

labrum is narrower than the glabella, and half its length; but from the position of its base its tip reaches back as far as the middle pair of glabella-furrows.

Thorax considerably longer than the head; the rings not very convex; the axis of nearly equal breadth with the pleuræ. These are traversed by a straight deep groove (fig. 36 *g*), curved rather abruptly down at the fulcrum, which anteriorly occurs at the inner third of their length, and in the posterior ring does not reach further than one fourth. The anterior edge of each pleura is sharpened or faceted to pass under the preceding one, and the posterior edge is thick.

Each pleura is bent forward at its end, which is notched somewhat deeply, and on the *under* side of each, in front of this notch, is placed a tubercle. When the animal was in the act of rolling up, the tubercle served as a buttress to prevent the posterior ring from being pushed too far forward; the tail, too, has similar tubercles on its anterior edge.

The under side, cleared out with great labour and patience by Mr. John Gray, of Hagley, shows two or three other interesting points distinctly.

First. The incurved under portion, which is very narrow in the tail, and not much broader beneath the border of the head. But along the pleuræ a wider strip is turned inwards, which is smooth in this genus, and has a straight inner edge; while it presents on its forward margin the tubercle before mentioned.

The interior ridges of the axis show distinctly along the axial line as short, transverse ridges, more prominent a good deal on their inner margin, which does not even show, except as a slight depression, on the upper side. This broad ridge does not extend into the tail portion.

Var. α, VULGARIS. Pl. II, figs. 17—25.

Figs. 22, 24, show about the ordinary form of the species; with broad glabella, complete glabella-furrows, and pointed front. The tail-furrows are strong, and the apex pointed. The axis of the body, too, is prominent.

Varieties.—Fig. 24 shows some tendency in the narrower glabella towards the variety *constrictus*, figured in the upper part of the plate. It has, however, very large eyes, like the var. *macrops*, but the tail wants the lateral furrows, or rather has them much slighter than usual, and the apex less pointed. The body-axis is narrow and prominent.

Fig. 23, a very large individual, is more convex than usual, and the eyes are depressed so as not to rise nearly to the level of the glabella. The tail is of the ordinary type.

Var. β, MACROPS. Pl. II, figs. 26—29.

The variety *macrops* is distinguished by the very large prominent eyes:—they occupy a large part of the cheek. I counted in one of them 140 lenses. The interspaces are granulated. Fig. 28, which belongs to this marked variety, has a larger head than usual,

and the tail has the side-furrows more than usually obsolete. Mr. Ketley's specimen, (fig. 27) has the front glabella-furrows strong, and the pleuræ flattened. The tail is of the usual type, but the side-furrows are obscured.

Var. γ, INFLATUS. Pl. II, figs. 30, 31 (32, 33?).

Fig. 30 shows a remarkable variety. While it retains most of the characters of the ordinary form, it nevertheless puts on a very different aspect. The glabella is greatly swollen, so as to be very convex, instead of flattened, in front. All the furrows are indeed distinct and in their proper situations, but from the inflation of the glabella they appear crowded. The eyes are small. Dr. Grindrod's cabinet and the Museum of Practical Geology are the only collections which I know to contain this variety. Probably fig. 31, a Ledbury specimen, belongs to var. β. It has the upper glabella-furrows all but obsolete.

On the other hand, figs. 32, 33, also from Ledbury, show all the furrows of the head and tail stronger than usual. These are casts of the interior, and the thickening of all the internal ridges is a constant character in *Trilobites*.

Var. ? δ, SPINOSUS. Woodcut, fig. 7.

FIG. 7.

Agrees with the ordinary variety α in the glabella, but has short head-spines! Only a single specimen is known; it is in Mr. Edgell's collection. With it, however, occurs a pointed and strongly furrowed tail, which may belong to it, and would mark it as a very distinct form; possibly a species.



Phacops Downingsi, var.
δ, *spinosus*. Upper
Ludlow rock, Ludlow.

But to pass on to a marked and definite variety, which has not yet received a name, and which would by many be considered a distinct species. I propose, however, only to term it—

*Variety or Sub-species*¹ ε, *CONSTRICUS*.

PHACOPS CONSTRICUS. Pl. II, figs. 13—16.

Minor, fronte convexiori rotundato haud angulato, oculis magnitudine variis, prope glabellam positus. Cauda rotundata, sulcis obscuris.

¹ I am much disposed to follow the plan adopted by some eminent botanists, and to make a distinction between the occasional variations in form and structure which are usually termed *varieties*, and those more permanent and well-defined groups, which are designated *sub-species*. Regarding these latter, there will always be differences of opinion as to whether they should receive separate specific names, and it seems the most convenient plan to describe them as distinct forms, which may be considered either species or varieties by the student, while their supposed relation to the parent species is indicated by their being grouped under it. We do not yet know what the limits of species and varieties are, and probably there is no real line to be drawn; but all truly distinct forms should receive attention, and, for the purpose of the geologist especially, a marked variety is as useful as a species.

This is smaller than the typical variety, seldom more than one inch long, and has a different aspect, from the rounding of the front and the greater convexity of the forehead-lobe. The glabella has nearly parallel sides, as in the typical form; the front furrow is not stronger than the rest, but is rather more sigmoid. The middle furrows reach the side of the glabella; the neck-segment is prominent and has a distinct tubercle. The eyes are small, with about 130 lenses, and placed very near the glabella.

The axis of the body is convex; the pleuræ more tumid between the grooves than usual. Some young specimens have larger eyes in proportion, and the front furrows obscure.

But these variations with larger or smaller eyes, more distinct or less distinct glabella-furrows, &c., occurring as they do both in the angulated and rounded varieties, oblige me to consider them as of the same species, though the characters above given show that we are dealing with a very distinct variety or *sub-species*.

There is yet another variety, which might be called var. ζ , *cuneatus*. Fig. 8.

Localities and Geol. Range.—The ordinary variety α is found from the May Hill Sandstone to Upper Ludlow Rock. MAY HILL Rocks; Pembrokeshire; Norbury and Bogmine, Shropshire. WOOLHOPE LIMESTONE AND WENLOCK SHALE; Malvern, many localities; Burrington, Shropshire; Usk, Monmouthshire; near Llanrwst, and many places in the Denbighshire grits, N. Wales. Pembrokeshire and Carmarthenshire, S. Wales. WENLOCK LIMESTONE of Dudley, Wallsall; Benthall Edge; Malvern; Abberley, &c. LUDLOW ROCKS, LOWER AND UPPER; Shropshire; Carmarthenshire; Pembrokeshire.

The varieties β , γ , above described, are as yet only known from the Wenlock Rocks; variety γ only from the Wren's Nest and Malvern; but the variety δ is from UPPER LUDLOW strata, Whitcliff, Ludlow (Mr. Edgell's cabinet); and the species or variety ϵ , *constrictus*, only from the Wenlock shale, of Dudley, Wallsall, and especially Malvern. Var. ζ is from the Denbighshire grits of Llanrwst, near Conway. (Woodw. Mus.)

Foreign distribution.—Nova Scotia, in Upper Ludlow rocks.

FIG. 8.



Phacops Downingtonia, var. ζ , *cuneatus*, from Llanrwst near Conway.

P. (ACASTE) APICULATUS, *Salter*. Pl. I, figs. 36—38.

PHACOPS APICULATUS, *Salter*, in Prof. Sedgwick's Synopsis Classific. Pal. Rocks, fasc. 2, Appendix iii, pl. i G, figs. 17—19 (1852).

PORTLOCKIA APICULATA, *McCoy*. Ibid. (1851), fasc. 1, 162.

PHACOPS APICULATUS, *Salter*. Memoirs Geol. Surv., Decade vii, art. 1, p. 9. (1853.)

— — — *id.* Siluria, 2nd ed. (1859), p. 75, Foss. 13, f. 2.

P. (Acaste) omnino P. Downingtonia simillimus, sed capite longiore. Glabella elongata antice convexior, lobis basalibus circumscriptis subtrigonis nec transversis; sulco mediano longiore, supremo distincto. Oculi elongati depressi. Anguli capitis brevissime mucronati. Cauda ad apicem compressa et in apiculum recurvum brevem producta, axi angusto.

Heads and caudal pieces of this small species are not uncommon in the Caradoc rocks

of Wales and Shropshire, but are rare in the Llandeilo flags. It is a smaller fossil than *P. Downingiæ*, though much like it, and is readily distinguished by the faint upper lobes of the glabella, and the strongly apiculate or shortly mucronate tail. The entire fossil could not have been above one and a quarter inch long, and is rather depressed than convex.

Head semicircular (smooth?), the front bluntly angulated, or, rather, like a broad Gothic arch. The glabella is long and parallel-sided, but slightly broader in front, and occupies less than half the width of the head. There is scarcely any margin in front of the forehead-lobe, the sides of which, above the eye, slope into the cheek without distinct axial furrows at that point. These are indeed but faint throughout, but are nearly parallel along the two upper lobes, and the basal lobes and neck-segment are scarcely narrower than the upper lobes. The neck-segment is strong and prominent; the basal lobes are transverse-oval, and deeply circumscribed, except on their inner margin. The uppermost furrows straight, oblique, deepest just over the eye, and thence extended nearly to the centre. The middle furrow is very faint, and gently arched upward: it nearly meets the margin, but is so faint that the two upper lobes appear like one.

The eye is small and conical, not much curved, and covers the space of the two upper lobes, leaving a wide space between it and the sharp neck-furrow. There is no marginal furrow to the cheeks on their outer sides, by which character it is easily distinguished from the following species. There is a very short mucro to each of the head-angles.

The tail is broad-triangular, and strikingly recalls that of *P. Downingiæ*. The largest we have is seven lines wide and five long, without the short recurved apiculus. The axis rather narrow, not nearly equal to the limb, regularly conic, ribbed by eight or nine distinct ridges, and the smooth terminal portion is pinched up, as it were, into the short apiculus. The axial furrows are not strong; the sides are convex, declining, and with a broad concave margin, not crossed by the side-furrows, which are five in number, and are deep narrow grooves, interlined pretty strongly on the cast (fig. 37), but less distinctly on the outer surface (fig. 38). Our figures do not express this as well as they ought to do.

Localities.—UPPER LLANDEILO FLAG. Treiorwerth, near Llanerchymedd, Anglesea. CARADOC SANDSTONE. Soudley, Horderly, and many other places in Shropshire; abundant; Cerrig-y-Druidion; Bala Lake; Llangollen; Meifod; Conway River; Pwllheli, &c., in North Wales; Coniston Water and Troutbeck, in Westmoreland.

PHACOPS (ACASTE) MIMUS, n. sp. Pl. I, fig. 35.

P. (Acaste) minor, capite elongato (angulis obtusis?). Glabella subparallela, haud convexa, lobis superioribus obscuris, basali distincto. Oculi submediani, modici. Genæ latimarginatæ, sulco antico exarato.

Though at first sight a good deal resembling *P. apiculatus* (p. 28), this little trilobite is

found to differ when closely examined. Its glabella is much the same in shape, but rather broader above; the basal lobes not so strongly marked, especially in the cast; the upper furrows less defined, and making a less indentation on the sides; the upper eye-lobe broader and flatter. The cheeks, without being smaller, project less at the (blunt?) angles and more at the sides, and the eye is a little further forward.

But the most striking character, although it seems to be an unimportant one, is the very distinct marginal furrow which subtends the eye closely in front, and leaves a strong, broad, anterior margin to the cheek. It does not, however, quite meet the neck-furrow, which rises towards it and runs nearly to the angle.

This apparently neutral character is nearly the only one on which we can rely; the rest are proportional characters. But the species is a distinct one; and although it is almost too imperfect to name, the little Lower Silurian oasis in Cornwall, from whence it comes, is of so much geological interest, that I venture to distinguish it. As the fossils of that area are wholly dissimilar from those of other portions of the British Silurian rocks, and only comparable with those of the "May" Sandstone of Normandy, it is worth while to note the discrepancy by describing even the more obscure species.

Calymene Arago, De Verneuil, and *Homalonotus Brongniarti*, Deslongschamps, accompany it, and will be described under their appropriate genera. The same set of fossils is found in the remarkable pebble-bed at Budleigh Salterton, in South Devon. See description of the next species.

There is a certain resemblance to *Dalmanites Phillipsi*, Barrande, and even to *Dalm. Hawlei*, Barr., from the Lower Silurian rocks of Bohemia. But *P. mimus* is sufficiently distinct from all.

Localities.—LLANDEILO FLAGS ? of Great Peraver, near St. Austell; in South Cornwall.

P. (ACASTE) INCERTUS, Deslongschamps. Pl. I, figs. 27, 28.

ASAPHUS INCERTUS, Deslongsch. Trans. Soc. Linn. de Calvados, vol. ii, p. 298, &c.,
pl. xx, fig. 5, 1825.

PHACOPS (DALMANNIA) INCERTUS, Rouault. Bulletin Soc. Géol. Fr., vol. viii, p. 371,
1851.

P. (Acaste) convexus, biuncialis, capite convexo, fronte angulato, caudá mucronatá. Glabella antrorsum parum dilatata, sulcis anticis haud profundis, posticis valde exaratis; mediano et postico arcuatis. Anguli genales brevispinosi. Cauda trigona lata; axi 9-annulato, convexo, in mucronem longum crassum recurvum producto; lateribus 6-sulcatis, sulcis interlineatis.

About two inches long. We have only head and tail, the former convex, with a glabella wider than the cheeks, and subparallel, or rather with the sides gently divergent in front (not abruptly, as in *P. socialis*; the front is bluntly pointed, as in that species).

The glabella-furrows are well marked on the cast, and reach fully two thirds inwards, towards the centre. The upper ones are oblique and sinuous; the middle pair arched

forward. The basal pair are by far the strongest, and enclose, in conjunction with the interrupted neck-furrow, a pair of transverse, oblong, nearly circumscribed, and very convex basal lobes, not so large as the middle pair. The contrast between the deep basal furrows and the fainter upper ones is striking, and is expressed by Deslongschamps' term "*postice bituberculato*."¹

The cheeks are regularly convex, the neck-furrow being strongly marked as far as the angle, which seems to have been armed with shorter spines than in *P. socialis*, Barrande ('Tril. de Bohême,' pl. 26), the species which is most nearly allied to ours. It is not, however, quite certain there were even *short* spines to the head-angles.

The outer side of the cheek is moderately arched, and margined by a fainter furrow than the neck-furrow, but continuous with it up to the angle of the head. The axial furrows are not very strong; and there is no margin in front of the glabella.

The eyes are small, placed centrally on the cheek, not in advance of this position. The facial suture beneath the eye is nearly direct to the outer margin, and vertical in front of the eye.

We have not the body. The tail also resembles that of *P. socialis*; but has a shorter mucro and fewer ribs. The shape is broad-triangular, a good deal wider than long; the axis narrow, conical, and rather convex, and at its apex curved upward and passing into a strong, thick, and greatly recurved mucro, whose exact length we do not know, but which was probably as long as the tail itself. There are six flat side-ribs, somewhat arched, and directed obliquely backwards; they nearly reach the very narrow, flat margin, and are interlined throughout. The sides are tolerably flat, except towards the apex, where they become tumid, and run into the broad base of the thick, recurved spine.

Comparing *P. incertus* with the very nearly allied *P. socialis*, we find the latter with a far more triangular glabella, the furrows of which are more equal; with spinous head-angles, forward eyes, several more rings upon the axis of the tail, which, besides, has more side-ribs and a much more slender spine—the latter less recurved. But the two species are nearly allied, and the group of trilobites, and shells also, which occur in the subjoined locality, are identical with those of the Lower Silurian sandstone of Normandy, where *P. socialis* also occurs, and some other Bohemian forms with them. The subject of the geographical distribution of trilobites is worthy of a separate essay.

Locality. LOWER SILURIAN pebbles, in the "Pebble-bed" of the New Red Sandstone, Budleigh Salterton, South Devon (Mr. Vicary's collection). Also in the "May Sandstone" of Jurques, Normandy (Eudes Deslongschamps).

¹ Deslongschamps' Latin description is short, and not very distinctive. "Clypeo triangulari, angulis brevibus incurvatis.....fronte magno convexo, antice acuto, postice bituberculato; genis parvis, oculis lateralibus" (p. 317).

PHACOPS (ACASTE) JAMESII, *Portlock*. Pl. 1, figs. 39—41.

PHACOPS JAMESII, *Portlock*. Geol. Report of Tyrone and Londond., p. 283, pl. 3, fig. 10, 1843.

— — — *Salter*. Decades Geol. Survey, No. 7, art. 1, p. 10, 1853.

— — — — In Morris's Catalogue, 2nd ed., p. 113, 1854, &c.

P. (Acaste) unciam latus; capite semicirculari, fronte subangulato marginato crasso. Glabella fere plana tuberculata, antice latissima, postice ad dimidium contracta, lateribus rectis: lobo frontali late trigono, oculos impendente; cæteris radiantibus, supremo maximo trigono, medio lineari obliquo haud abbreviato, basali transverso; lobis omnibus fere ad medium glabellæ, spatio angusto interjecto, conniventibus. Genæ declivæ marginatæ, angulis obtusis. Oculi abbreviati valde curvi. Thorax? Cauda rotundata, quam longâ tertiam partem latior, depressa; axi satis magno conico, marginem nullo modo attingente, annulis 8—9; lateribus sulcatis, sulcis 6—7 æqualibus, læviter per totum interlineatis.

I have seen but four or five specimens of this. But the species is not uncommon in Waterford. It is a marked one, conspicuous for the flatness of the glabella, and the thickened outer border. The cheeks are triangular; the eyes have a peculiar angular upper lobe. The tail is a good deal like that of *Calymene*, and the whole aspect is unusual for *Phacops*. *Portlock's* figure, which, like all the rest of his plates, were but second-hand office copies of Mr. Dunoyer's beautiful drawings,¹ gives no proper idea of the species, which is named in honour of Lieut.-col. James, of the Ordnance Survey.

P. Jamesii must have been nearly two inches long. It is very gently convex, the head flattened above, the cheeks declining rather steeply. The glabella, covered closely with not very coarse tubercles, occupies much more than half the width of the head, especially in front, where it is very broad, the sides converging behind at about 70°. The forehead-lobe is abruptly wider than the rest, overhanging the eye. It is transverse, subangular in front, with a thickened margin, and behind bounded by the nearly straight upper furrows, which run far towards the middle, and are of equal strength throughout. The other furrows radiate, the middle ones declining towards the base of the eye. The basal ones more direct, nearly parallel to the neck-furrow. The axial furrows are very faint.

The eye is small, strongly curved, set near the glabella, and on a level with it; the upper eye-lobe is pointed, the lentiferous surface imbedded, as it were, in a fold of the cheek, which is here convex, but declines all round, and slopes away to the margin. The cheek itself is triangular, with obtuse outer angles, and is only granular, not tubercular, strongly marginate on the outer side, and with a sharp neck-furrow, which does not meet the marginal furrow.

Tail semicircular, one third wider than broad, depressed (this is not due to pressure).

¹ The original plates were found to be rather too large, and unfortunately had to be cancelled.

Axis rather large, not equal to the limb, conical, rounded at the tip, and reaching less than four fifths of the whole length; annulated throughout by about nine rings; the sides with seven furrows directed obliquely, and reaching nearly to the margin, interlined throughout.

The species is unlike any other, but has perhaps its nearest relations with *P. alifrons*, next described. From that species the shape of the forehead-lobe will distinguish it, while there is only some general resemblance in the shape of the flatter glabella, and especially in the small, greatly curved eye.

Locality. CARADOC ROCKS of Waterford; Tyrone. (Mus. Pract. Geology.)

PHACOPS (ACASTE) ALIFRONS, *Salter*. Pl. I, fig. 31—34.

PHACOPS ALIFRONS, *Salter*, in Appendix to Sedgwick's Synops. Woodw. Foss., fasc. ii, tab. 1 c, figs. 12—14, 1852.

— — *Ibid.* In Decade 7, Geol. Survey, Art. 1, p. 10, 1853; and Morris's Catal., 2nd ed., 1854.

P. (Acaste) capite tuberculato sesquiunciam lato, gibboso, anticè truncato, bis quam longo latiori. Glabella elevata sed paullum convexa, ad basin angustata, superne dilatata obtusa truncata, lateribus subrectis; lobo frontali brevi transverso limbum crassum impendente, utràque angulis tumidis cum margine genarum confluentibus; lobis lateralibus tumidis, supremo subtrigono modico, reliquis fere rotundis abbreviatis; genis declivibus marginatis. Oculi curvati. Cauda semicircularis tumida, axi lato convexo 8—9 annulato, apice obtuso nec marginem attingente; lateribus convexis, costis 7—8 simplicibus; margine angusto.

We are compelled to be minute in the specific characters of these species of Phacops, as they really differ but in proportional characters; yet, if it were allowable to abbreviate, it would certainly be excusable in this case, for in no other species which I know does the outer and upper angle of the glabella run out distinctly into the margin as it does in this fossil. But three or four heads of it are yet known, and two or three caudal shields associated (not in actual contact).

The species was a tolerably large one, the head (in our largest specimens, copied from the figure formerly given by myself in Professor Sedgwick's work) is $1\frac{1}{2}$ inch broad. The entire form may have been 3 inches long. The lesser figure (fig. 33) represents a somewhat smaller, but characteristic specimen. Both are from North Wales, and I do not know it elsewhere.

The head is highly convex, and rather strongly truncated in front, but the glabella, though tumid, is rather depressed on its upper surface. It is very wide in front, the upper lobe overhanging the eye; and being connate with the thickened border of the cheek, seems to be drawn out into it. The lateral lobes are short, the upper largest, but not greatly so, triangular; the upper furrow which bounds it running nearly straight across (not upward, as in *P. Jamesii*); the second, as deep, directed downward and out-

wards; the rest are short and rounded, the base-lobes narrow, the neck-segment prominent.

Cheeks very convex, separated by deep axial furrows from the glabella, strongly circumscribed in front by the deep marginal furrow, and behind by the neck-furrow; the angles rounded, not spinous? Eyes prominent, small, curved, somewhat sunk, overhung by the angles of the glabella.

Of the tail we have but few specimens; our largest is that figured in Professor Sedgwick's work. It is semicircular and very convex; with a broad, prominent axis reaching nearly the whole length, and blunt at the apex; ringed throughout by eight or nine ribs, and with no smooth terminal portion. The sides are also convex, with about eight simple, radiating ribs, not much curved, and with no intermediate furrows. The ribs abut abruptly against a narrow but distinct margin. The other tail (fig. 34) is less certainly of this species, but is found associated with it. It has a wider margin, and only seven lateral furrows.

Localities.—CARADOC ROCKS, North Wales; at Capel Garmon, near Llanrwst; also at Penmachno, and Pont-y-Glyn Diffwys, near Corwen; and near Llangynnog, in Montgomeryshire. (Mus. Pract. Geol. and Woodw. Mus.)

PHACOPS (ACASTE) BRONGNIARTI, *Portlock*. Pl. I, figs. 20—25.

♂ ? P. BRONGNIARTI, *Portlock*. Geol. Report, pl. 2, fig. 8 (exclude the references), 1843.

P. MURCHISONII. Ibid., fig. 9.

Var. ♀ ? P. DALMANI. Ibid., fig. 7.

P. BRONGNIARTI and P. DALMANI, *Salter*, in Decade 7, Geol. Survey, Art. 1, p. 10, 1853; and in Morris's Catalogue, second edition, pp. 112, 113, 1854.

♂ *P. biuncialis, elongatus, granulatus; capite longo trigono, fronte angulato subrecurvo. Glabella ad basin contracta, anticè valde dilatata nec convexa, lobis utrinque tribus radiantibus; lobo antico maximo triangulato, a frontali sulco valido—a medio sulco leviori—sejuncto; lobis infimis minutis hæmisphericis circumscriptis sese remotis. Oculi maximi, a lobo frontali usque ad sulcum cervicalem tracti. Anguli genarum obtusi. Thorax lateribus parallelis, axi convexo angustato, pleuris abruptè deflexis apicibusque rotundatis—fulcro intra medium posito. Cauda trigona, axi longè conico angustissimo ferè ad finem caudæ extenso, 10-annulato; lateribus 5-costatis, costis per totum divisis, nec marginem levem attingentibus.*

♀ or var. *Dalmani*, figs. 25, 26.

Omnino precedenti simillimus, glabellá, caudá, oculis—sed fronte capitis rotundato nec producto.

This is not a difficult species to recognize, once its peculiarities are mastered; but it occurs in a variety of forms, and these are rendered more obscure by the changes the rock has undergone. It is common in the sandy schists of Tyrone, and not unfrequent in North Wales and other places. Colonel Portlock thought it identical with the *P. macrophthalma* of Brongniart and the *P. Downingiæ* of the Wenlock Rocks; and to avoid the confusion of using these controverted names, proposed to term the combined species *P. Brongniarti*, after the author of the 'Crustacés Fossiles.'

But, as I have shown in the Decades of the Survey (*l. c.*), these are really three very distinct species, and we must limit Portlock's name to the species described first by him. His *P. Murchisonii* is only a synonym. But it is with some little doubt I include the *P. Dalmani*, a form with rounded front, but otherwise exactly like the species with which it is associated. As I find Welsh and Irish specimens with an intermediate character, I do not think it can be wrong to unite these two, and I take the pointed form to be the ♂, and the more rounded variety (*P. Dalmani*) to be the ♀ form. The ♂ is the more common of the two.

Two inches long, elongated, and tolerably convex, the head occupying less than one third the whole length; subtriangular, and with the front produced and recurved (in the *P. Brongniarti* ♂; semioval and with a rounded front in the ♀ form, *P. Dalmani*;) the glabella itself is of the same shape in both varieties, tubercular all over, contracted at the base, expanded in front, but not convex, and with radiating lobes. The forehead-lobe is subrhomboidal and transverse, the upper lateral lobe large, triangular, and overhanging all the rest, but not so large as to render them obsolete. The mid-lobe is directed backwards, and is parallel-sided, and about half the length of the front one. The basal lobe is transverse-linear, contracted at the sides, where it forms a tubercle, and the neck-lobe is again broader and thicker and more elevated than the rest. This is less conspicuous in the ♀ form. The cheeks are triangular, and concave outside of the very large eye, which reaches forward beyond all the lateral lobes, and backward to the neck-furrow. It is considerably arched, rather depressed, and has numerous small lenses (about eight in a vertical row, and in all 170 in each eye). The eye-lobe or -lid is strongly furrowed parallel to the lens-bearing surface. The space between the eye-lobe and the glabella is convex, and of an oblong shape. Angles of the cheeks obtuse, not spinous. Thorax with a convex, narrow axis, and with pleuræ which are steeply bent down at about the first third of their length; the fulcrum placed within the middle point; the ends of the pleuræ blunt and arched forward, and their facets large.

The tail is triangular, pointed in the ♂, obtuse in the ♀ form, rather convex; with a long conical axis reaching nearly to the narrow margin, and interlined strongly by intermediate furrows, which project beyond them and quite reach the margin, undulating it most strongly in the ♂ form.

I see no reason for separating the two trilobites quoted above as specific forms. All the characters are more strongly pronounced in the form which I suppose to be the ♂,

and which has both the apex of the tail and the front of the head more prominent and produced than in the other variety. The North Welsh specimens are intermediate, the cheeks steeply bent down, the margin of the eye-lobe narrower, and the lenses more numerous; occasionally ten in a row, in the widest part of the eye.

P. macrophthalmia of Brongniart, with which the first describer of this species united it, has neither the obsolete basal lobes, nor greatly expanded glabella, nor the large eye of the one we have been describing. And there can now be no question of uniting either of these with the Dudley fossil included by Brongniart (described above as *P. Stokesii*), all subsequent writers having adopted the distinctions.

It is, however, worth while to compare our species with the fossil figured by Dr. Pander, in his 'Beiträge zur Geogn. Russ.,' pl. v, fig. 7, and pl. vi, fig. 9. It has large eyes like ours, but the glabella-lobes differ considerably. And at all events, it is not the *P. macrophthalmia*, to which he refers it.

Localities. — CARADOC, Tyrone, abundant; Kildare; Wexford; and Waterford, in Ireland. Llanfyllin and Llanwddyn, Montgomeryshire, in North Wales. (Mus. Pract. Geology, &c.)

Sub-genus—CHASMOPS, *M. Coy.*

Though not quite convinced that this is a definable sub-genus or section of *Phacops*, I adopt it because it conveniently bridges over the space between *Acaste* proper and the typical species of *Odontochile*. The *P. conophthalmus*, Boeck, is the type of the section, and has to perfection the enlarged upper lobes of the glabella and the expanded forehead-lobe, while the tail is only of moderate size, and has but eight or nine segments.

P. macroura, again, is typical so far as the head is concerned, but has very numerous segments to the tail, a characteristic still further carried out in such species as *P. truncato-caudatus*, which may be considered as linking on the sub-genus *Chasmops* to *Odontochile*, as *P. Jukesii* links it to the ordinary *Acaste*.

Altogether the group has a wide range, and tends to show the unity of the genus *Phacops*.

PHACOPS (CHASMOPS?) JUKESII. Pl. I, figs. 29, 30.

? PHACOPS SCLEROPS, *Dalman*. Palæadæ, t. ii, fig. 1, g, icon mala, 1826.

PHACOPS JUKESII, *Salter*. Decades Geol. Surv., No. 7, Art. 1, p. 11, August, 1853.

— — — *Id.*, in Morris Catal., 2nd ed., 1854.

P. (Chasmops vel Acaste) modicus, unciam latus, granulosus, capite transverso ferè quam longo ter latiore; glabellâ dilatatâ, lobis omnibus distinctis. Glabella subconvexa, frontem impendens, latè triangulata, anticè valdè dilatata, nec cum margine connata, posticè contracta, utrinque triloba; lobo basali transverso lineari, secundo paullo majore rotundato, supremo magno triangulato, frontali maximo transverso oculos imminente, cervicali elevato. Sulci axillares profundi. Genæ latæ marginatæ, transversæ—angulis rotundatis?, sulco cervicali forte exarato, lineâ faciali impressâ.

It may be doubtful if this species be not included in some of the varieties of *P. sclerops*, Dalman; but it is clearly distinct from his typical form, as we know by specimens in the cabinet of Sir R. I. Murchison. And it well deserves a name, being a most characteristic form, which somewhat tends to connect the ordinary species of *Acaste* with the more extravagantly lobed species of *Chasmops*. I scarcely know to which sub-genus it should be more properly referred, and place it first. We have only two specimens.

The head is above an inch wide, and scarcely more than one third its length; convex and granulose, with coarse and fine grains equally all over. The glabella not convex, but greatly dilated in front, and contracted behind to one fourth the width. The forehead-lobe is widely transverse, and overhangs completely the triangular upper lobe, which in its turn is imminent over the mid-lobe, and about twice its size. The middle lobe is, however, wider than the narrow basal lobe, which is not reduced to a mere tubercle on the sides, nor contracted to a much less width than the rather prominent neck-lobe.

The cheek, strongly margined in front, is of a narrow triangular shape, and is deeply divided from the glabella. The eye, much curved, is opposite to and covers the space of the two upper lobes, and is itself overhung by the upper lobe.

The facial suture is deeply marked outside the eye; it nearly bisects the cheek, and runs parallel to the deep neck-furrow.

A young specimen does not differ in any material respects from an older one.

Locality. CARADOC ROCKS of Gelli grin, near Bala, North Wales. (Mus. P. Geology.)

P. (CHASMOPS) MACROURA, Sjogren, Pl. IV, figs. 18—23.

ASAPHUS POWISII, *Murchison*. Silurian Syst., pl. 23, fig. 9 (head only), 1837.

DALMANIA AFFINIS, *Salter*. Memoirs Geol. Survey, vol. ii, pt. 1, pl. v, fig. 5, 1848.

PHACOPS TRUNCATO-CAUDATUS, var. β , AFFINIS, *Id.*, in Decade Geol. Surv., No. 2, Art. 1, p. 7, 1849.

ODONTOCHILE TRUNCATO-CAUDATA, *M'Coy*. Synops. Foss. Woodw. Mus., t. i G, fig. 20 (21 ?) (not *Chasmops Odini*, same plate, figs. 22, 23), 1851.

PHACOPS MACROURA, *Angelin*. Palæont. Suecica, t. vii, figs. 3, 4, 1852.*

P. (Chasmops) ovatus magnus, capite semilunari, vix quam longo bis latiore, tuberculoso, caudâ elongatâ submucronatâ multi-annulatâ. " Glabella parùm convexa, anticè valdè dilatata, lobo frontali maximo triangulato oculum imminenti ; lobis lateralibus supremis magnis triangulatis quam latis multo longioribus, medianis obsoletis, basalibus contractis, cervicali lato. Genæ convexæ nec gibbæ, declivæ, glabellâ angustiores, angulis in cornua lata longa extensis ; oculo majore, sulco circumdato, linea faciali impressâ. Cauda magna trigona convexa, apice acuto, axi lato per $\frac{4}{5}$ longitudinis extenso, annulis 16 ; costis lateralibus circa 16, ferè rectis, vix interlineatis, sub apice radiantibus.

All the above names have at various times decorated or disfigured our fossil, which labours under the combined disadvantages of being very common and conspicuous, and seldom at all perfect ; and also of belonging to a group of closely allied species which occur in company, and have been hitherto always badly figured. I can hardly hope to have remedied *all* these defects, and only give those synonyms of which I am assured. The name *Phacops conophthalmus*, under which it is generally known in cabinets, really belongs to a species with short head-spines, smaller eyes, wider cheeks, and altogether a more transverse form of head, and a short tail. We must wait for a more complete knowledge of this group of trilobites ; and meanwhile our figures represent truly the most conspicuous of these forms, and certainly that figured by Prof. Angelin. The numerous ribs of the tail and the great head-spines readily distinguish it.

The *P. bucculenta*, also figured by Angelin, has a large, many-ribbed tail, but has only a small pair of lateral glabella-lobes instead of the great encroaching pair distinctive of the *P. macroura*, and which have procured for this grotesque-looking species the name among collectors of the 'Cat's-head Trilobite.'

There are other allied species both in Scandinavia and North America ; but the group appears to be peculiar to this northern zone, and does not occur in mid-Europe, as M. de Barrande has specially remarked.

General form rather narrow, ovate, blunt but abruptly angulate in front, and shortly pointed behind. The head is about as long as the tail, and not quite twice as broad as long ; very convex ; semilunar, with a very wide glabella, larger than the cheeks, the sides of which converge behind at about 50°. The cheeks are very convex, deeply margined, and produced behind into exceedingly broad, flat, and rather lengthened parallel spines, at the inner angle of which the strong marginal and still stronger neck-furrow meets.

* The cover of this excellent folio is marked 1851 ; but in order to preserve priority of date, it is necessary to be exact. It seems to have appeared Jan., 1852.

The lobes of the glabella are as follows:—The forehead or frontal lobe transverse, rhombo-trigonal, depressed in the centre, twice and a half as wide as long, rounded-truncate at the upper angles, and only a very little overhanging the position of the eyes. The great lateral “cat’s-ear” lobes are right-angled triangles, with the corners rounded off, their larger angle inwards, and only slightly sinuous above, and they occupy in length full half the side of the glabella, and reach more than one third across it, bounded on all sides by very deep furrows. A narrow, triangular space is left between the bases of these lobes for the lower pairs; the middle lobes are minute, and mere tubercles; the basal lobes more extended, but still narrower than even the base of the upper lateral lobes, which completely overlap them. The neck-furrow is very strong, and equal across; the neck-segment of equal width throughout, but its whole breadth is scarcely one half that of the frontal lobe.

The axial furrows are very deep, and tolerably straight, the cheeks rising very convex from them, bearing the small, strongly lunate eyes.* These have about 160 lenses rather small, and very little prominent, and the pits containing them have on the interior cast an elevated rim or border. The eyes are placed opposite the centre of the frontal lobe, about half way up the cheek, and their own width from the glabella; a deep channel surrounds its base. All the furrows of the head are deep, the marginal one especially so, and the neck-

furrow is much curved to follow the descent of the great head-spines. These latter are broad, flat horns, pressed against the body, and extend back a great way, as shown in our woodcut.

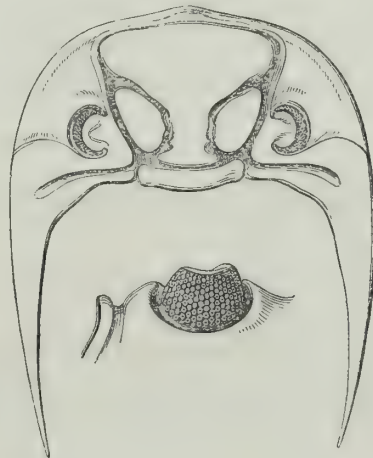
The surface of the head—the glabella especially—is largely tubercular; and in fig. 20 a curious double row of deep puncta runs half way down the forehead-lobe from the emarginate front. But this is perhaps not repeated in other specimens.

The facial suture is not strictly marginal in front, but a little above the margin. Outside the eye it takes a forward curve, and here it lies in an impressed groove. The labrum (fig. 21) has a very broad, arched base, and a blunt-pointed end. The body of the labrum is strongly separated from the wings, and its sides are parallel for a short distance, then converge to the rounded obtuse point. There are two deep concentric furrows; the outer one quite continuous, very strong, and remote from the apex. Above these the organ is convex and roughly tubercular; beyond them it is flat. There is a deep perforation (*a*) in the broad basal wing, which indicates the place of the ascending process of attachment.†

* I think Prof. Angelin’s figures are not correct as to the eyes. The cornea must have been thin.

† This varies in shape in various species. The form above indicated is a rare one.

Fig. 7.



P. macroura, a perfect head in Mr. H. Edgell's collection: the eye magnified.

The tail, from very perfect specimens (figs. 19, 22, 23) is subtriangular, with rounded sides and apex; pointed, highly convex; the sides regularly so, without any flattened border. The axis is broad, and very gently convex; much more than half of the width of the broad limb, regularly conical, and reaching four fifths the length of the tail. It is annulated to the very tip by sixteen sharp rings. The sides are deeply grooved by sixteen* nearly direct strong furrows, faintly interlined throughout, which gradually radiate downwards, till from the tip of the axis they become longitudinal. Three or four longitudinal ridges run from the tip to the end of the tail, thus completing the fan-like arrangement.

The incurved portion of the tail, seen in the small specimen (fig. 23), is narrow and granulated, as the whole tail appears to have been.

Locality.—CARADOC SANDSTONES of Shropshire; plentiful in many places. (Cabinets of Messrs. Lightbody and H. W. Edgell; and in the Ludlow Museum, and Mus. P. Geology).

P. (CHASMOPS) CONOPHTHALMUS, *Boeck?* Pl. IV, figs. 24, 25, and Pl. VII, fig. 25.

TRILOB. CONICOPHTHALMUS, *Boeck*. *Gæa Norvegica*, i, 4, 1838.

PHACOPS — *Emmrich*. *Dissert.*, 21, 1845.

CALYMENE ODINI, *Eichwald*. *Sil. Syst. Esthland*.

— — *De Verneuil*. *Geol. Russia*, t. xxvii, fig. 8.

PHACOPS SCLEROPS, *Burmeister*. *Org. Trilob.*, ed. 2, tab. iv, fig. 5, 1846.

— CONOPHTHALMUS. *Ibid.*, p. 91.

— FELINUS, *Salter* (MS.). *Ibid.*, Appendix of Species, p. 125.

— CONOPHTHALMUS, *Angelin*. *Palæont. Suecica*, t. vii, figs. 5, 6, 1852.

— — *Salter*. *Decades Geol. Survey*, vii, Art. 1, p. 7 (exclude other synonyms than those above), 1853.

CHASMOPS ODINI, *McCoy*. *Synopsis Woodw. Mus.*, t. i g, figs. 22, 23, 1851.

P. (Chasmops) ovatus, capite valdè transverso, quam longo ferè ter latiore, granuloso convexo [caudâ brevi, 8—9 costatâ]. Glabella convexa, anticè valdè dilatata, lobo frontali maximo triangulato, oculum parvum imminente, lobis lateralibus supremis magnis rotundato-trigonis, medianis obsoletis, basalibus linearibus, cervicali lato. Genæ convexæ ferè gibbæ, marginatæ, angulis in cornua breviter extensis, oculo brevi, lineâ faciali impressâ. Cauda [associata] lata, punctata, vix marginata, axi conico 9—10 annulato; costis lateralibus 8 arcuatis, duplicatis.

The head of this species differs at a glance from the one above described, in being so much more transverse, only half as long as it is broad, and rather semicircular than semilunar. Though fig. 25 (copied from my own original figure in the 'Cambridge Synopsis') is not quite perfect—it is only the internal cast—there is enough to show that it agrees better with Angelin's *P. conophthalmus* than the other species; and the tail

* Angelin's figure has 19 axial, and 18 side ribs.

figured with it in the same work, will agree pretty well with Burmeister's figure of *P. conophthalmus*, in his later and improved edition;* much better than with Angelin's figure, which surely represents the tail as too pointed, and he describes it with twelve lateral ribs to the tail. We are still at sea about this species, but must accept Angelin's figure as the type, as he has access to all the described Swedish species. I only describe our own, and believe it will by and by constitute a new species.

The head is transverse, semicircular but obtuse in front, and more than twice as wide as long; very convex; granular, not tubercular; and with the wide glabella occupying much more than one third of the head. It is nearly a right-angled triangle, with the corners rounded off. The forehead-lobe is widely transverse, and considerably overhangs the eyes. The upper lateral lobes are large, but not expanded forwards, only behind, and rounded-trigonal; their transverse diameter fully equal to, if not greater than the fore and aft measurement. The mid-lobes are quite obsolete, and the basal one transverse-linear, and smaller than the neck-lobe. The cheeks are equilateral triangles, very convex, and bear centrally the small eye, which is subtended by a much deeper furrow than in *P. macroura*. The neck-furrow is strong, and continuous with the marginal furrow, but the margin is in no part very broad. Head-angles short-spinous.

The tail (which occurs in the same locality, and probably belongs to the same) is transverse, "its length nine lines, against a breadth of fourteen lines; the axis convex, of ten segments, and about two thirds the width of the side-lobes in front; abruptly narrowed after the fifth segment. There are about eight lateral segments" (M'Coy). The ribs are much arched, and reach quite to the margin; strongly interlined throughout. The surface of the tail is strongly punctate.

This obtuse, short caudal portion is very like that figured by Burmeister in the Ray edition of his work. It is more like the tail-piece of a large *Calymene* than a *Phacops*. Not having access to the Cambridge specimens at present, I had thought of leaving this and some other doubtful species for a supplement, but prefer to present it, with other fragments, in our Plate VI, and so complete what we at present know of this obscure species. Collectors will do well to pay special attention to this fossil, as it is a characteristic northern form.

Locality.—CARADOC SLATES of Llansaintffraid, Glyn Ceiriog, south of Llangollen, North Wales. Also at Acton Scott, in Shropshire (Mr. H. W. Edgell).

I omit other localities, but one or the other of the above two species occur throughout North Wales, at Llanfyllin, Llanwddyn, and Meifod, Montgomeryshire; Pwllheli and Bettws-y-coed, Caernarvonshire. In South Wales, at Llandeilo. In Westmoreland, at Coniston, Troutbeck, and Rother Bridge. In Clare and Kildare, Ireland.

* Ray edition, 1846. He describes the tail as having nine lateral ribs—the number present in a specimen from Christiania in the Mus. Pract. Geology.

P. (CHASMOPS) AMPHORA, *Salter*. Pl. IV, fig. 16.

PHACOPS (DALMANIA) AMPHORA, *Salter*. Decade Geol. Survey, vii. Art. 1, p. 12. 1853.

P. (Chasmops) caudá magná biunciali elongatá, convexissimá, fere semicylindricá. sulcis axialibus fere obsoletis. Axis latus nec eminens, marginem angustum inflexum haud attingens, in annulos 16 subplanos divisus, apice obtuso. Latera valde curvata deflexa, costis 14—15 planis, sulcis acutis separantibus, costá quáque lineá medianá lævi elevatá sub cortice tenui impressá; apice obtuso (emarginato?).

This species must be closely allied to the preceding. It differs only in proportions, but markedly so, being greatly more convex in the only portion we know—the tail; it is almost semicylindrical in shape, and the axis much less distinct from the sides than in *P. macroura*. It is also, but somewhat more remotely, allied to *P. truncato-caudatus*.

The large tail, which must have been fully two inches long, is but a little more than this in breadth. It is more than half a cylinder, the curvature being remarkably regular and even, the axis scarcely projecting beyond the general convexity, and scarcely divided from the sides by any depth of axial furrow. The axis is broadly conical, and below rounded off towards its apex; it reaches fully five-sixths the whole length of the tail; and is made up of sixteen rather flat rings. The four or five front ones show a false articular surface, distinctly; the real articular surface is very large and distinct.

The side-lobes are in reality half as wide again as the axis, but on a front view do not appear so, owing to the great convexity; the surface is curved steeply down, and is scored by fifteen deep sharp furrows, separating sixteen prominent flat ribs, much wider than the furrows. Each rib has an interrupted chain-like dividing line down its middle. The same occurs, somewhat exaggerated, beneath the crust, on the cast. But the perforations here are so arranged as to leave a crest-like ridge. The dividing lines extend nearly to the end of the ribs, which cease rather suddenly near the steep, almost vertical or inflexed, marginal rim.

The shell or crust of this species is remarkably thin. Except some species of *Homalotus*, I do not know any kind of trilobite which has so cylindrical a form.

Locality. CARADOC LIMESTONE of Grug, N. of Llandeilo, Carmarthenshire. Collected and presented to the Mus. Pract. Geology, by Mr. Williams, of Llandeilo.

P. (CHASMOPS) TRUNCATO-CAUDATUS, *Portlock*. Pl. IV, figs. 13—15.

PHACOPS TRUNCATO-CAUDATUS, *Portlock*. Geol. Rep. Tyrone, 1. c., pl. ii, figs. 1—4, 1843; *Paradoxides Bucephali*, *ibid.* (labrum only), pl. i, fig. 8.
 — — — *Salter*. In *Morris*, Catal., 2d ed., 1854.
 — — — (DALMANIA) *Id.* Decade II, Geol. Survey, Art. 1, p. 7, 1849; (exclude the synonyms of *D. affinis*, for which see *P. macroura*).

P. (Chasmops) granulatus, capite antice truncato, oculis maximis subdepressis, pleuris obtusis, fulcro ab axe valde remoto. Cauda axe 18-annulato angusto, costis lateralibus 14—16, apice emarginato.

An obtusely ovate form, strongly truncate in front, and obtusely pointed behind. The head widely transverse, fully two and a half times as wide as long, and with the glabella so expanded along the front as to occupy more than half the width of the head, and overhang the middle of the large eyes. Thence the glabella abruptly narrows to half this width, sloping inwards to the base of the middle lobe; but from this point it is again parallel-sided to the base (in *P. macroura* the shape is triangular, here it is turbinate).

The upper glabella-lobes are quite overhung by the frontal lobe, and are not greatly larger than the succeeding lobes. They are right-angled triangles, with the obtuse right angle outwards, not inwards as in the preceding species. The space between them is fully equal to the width of the lobes themselves; their length is two thirds that of the great eye. The middle lobes are rather smaller, narrower, and somewhat linear, but tumid at the sides—(and not overhung and rendered obsolete as in *P. macroura*). The basal lobes are still narrower, more linear, and less tumid; the neck-lobe of the same shape as the basal lobes. The whole glabella, as well as the cheeks, and all the rest of the head is thickly covered with large granulose tubercles.

The cheeks are not large, and are chiefly occupied by the semilunar eyes, which reach from the front furrows nearly to the neck-furrow. They are much curved, the eye-lobe strongly margined, with an angular fold along the middle. Cheek-spines large.

Axis of the body-rings gradually widening behind; rather convex, especially along the middle part, which is wholly covered with granules. The sides of the axis are nodose on every joint. The axial furrows strong, the pleuræ not very much wider than the axis, flat as far as the remote fulcrum, which is fully two thirds out. Pleural groove deep, very oblique, and leaving a strong node on the proximal or inner end of the pleura, against the axis. This is a conspicuous character. Tubercles, larger and smaller ones, are visible over the whole surface. Tail broadly half-ovate, convex, but regularly so, except the concave narrow margin. The axis not very prominent nor strongly separated from the sides, tapering, narrow, with straight sides, composed of eighteen rings nodular (as the axis of the body, but on a smaller scale). Sides of tail depressed, with fourteen or sixteen flattened radiating ribs, with a somewhat sigmoid curve; the ribs separated by sharp furrows which run almost to the margin. The ribs are granular throughout; there is an imperfect double row of granules on each flattened rib—the space between the rows representing the interlining furrow, which is not present in this species.

The apex of the tail is, as in most of the allied forms, emarginate and a little raised; a ridge runs to it from the angular termination of the axis, as in kindred species.

The labrum or epistoma, fig. 15, has the wide arched base characteristic of the subgenus. It is gently convex and somewhat angular in form (but subparallel at the base) with a shallow notch for the ascending process. The concentric pair of furrows are deep;

the outer pair continuous as a marginal furrow, the inner very oblique. The apex is angular, but blunt.

Localities. CARADOC of Desertcreat, &c., Tyrone. (Mus. Pract. Geology).

PHACOPS (CHASMOPS) BAILYI, n. sp. Pl. VII, figs. 21—24.

P. (Chasmops) satis magnus, capite subangulato; glabellá dilatátá, lobis omnibus distinctis; caudáque (associatá) rotundatá multiannulatá. Glabella longa elevata tuberculosa lobo antico rhomboideo transverso, lobis lateralibus inæqualibus, supremo magno rotundato trigono, secundo paullum abbreviato, basali majori, cervicali expanso. Oculi elevati. Cauda semi-ovalis, apice rotundato obtuso; axe longo conico 10—11-annulato; costis lateralibus 11 planis, arcuatis, lineisque intermediis distinctis ad apicem uná cum primariis connatis.

It is scarcely doubtful that this is a *Chasmops* rather than *Odontochile*. It certainly has many affinities with *P. truncato-caudatus*, to which Mr. Baily referred it in the Irish collection. He has judiciously preserved every fragment, and in this way we have been enabled to reconstruct the species.*

The head is rather elongate, the glabella somewhat depressed and widely clavate, broad above the wide forehead, and actually overhanging the eye, and narrowed behind; all the lobes distinct and somewhat radiated. The forehead-lobe is transverse and rhomboidal, separated by an arched furrow from the rounded, triangular, upper lateral lobe, and this by an oblique downward furrow from the much smaller mid-lobe, which is triangular in the reverse direction. The basal lobes are large, and tumid at the sides; the cervical lobe is wide. The eyes prominent, and placed rather forward, on a somewhat sharply elevated cheek. The margin of the cheek narrow, and not strongly defined. The facial suture runs in a broad ogive some distance within the front margin, which is slightly angulated.

Of the tail we have one external and three interior casts, which show it to have been a large semioval plate, broader than long, but rather abruptly narrowed behind, and with a rounded obtuse end. The axis is narrow and conical (but broader than in *P. truncato-caudatus*), reaches five-sixths the length of the tail, and has ten or eleven rings at least. The axial furrows are deep, and the sides are convex, and scored by eleven narrow sharp furrows; the ribs between which are flat and interlined all along, much in the same way as in *P. macroura*. The upper ribs are duplicated very strongly. The margin is very narrow.

It is very like *P. macroura*, above figured, and differs from *P. truncato-caudatus*, fig. 13, both in the shape and proportions of the glabella-lobes, and in the much narrower segments of the tail, and it does not need comparison with other British species.

Locality.—CARADOC SLATES of Tramore, Co. Waterford. (Mus. Irish Industry, Nos. B 647, 650, 652.)

* Many species are lost from want of care in the collocation of fragments of specimens. Very often, indeed, in slate-rocks, the species must be truly reconstructed from the *dissecta membra*, and with judgment this may generally be safely done.

Section.—ODONTOCHILE.

If there were some doubts of the limits of the subgenus CHASMOPS, there can be none at all of the general character of that which Emmrich called *Dalmania*, and which name was rightly changed to *Odontochile* by Corda, *Dalmania* having been in previous employ.

Large expanded forms, with the glabella wider in front, and with the lobes nearly equal or only gradually increasing forwards; a depressed habit, and a caudal shield composed of many segments (technically more than eleven), give a combination of characters easily enough recognisable among the large Trilobites, which chiefly occur in Upper Silurian rocks; a few began in the Lower Silurian, a few extend into the Devonian; but the bulk of the subgenus are to be found in Wenlock and Ludlow rocks, and the genus is world-wide.

We have in this section the largest and most conspicuous of the *Phacopidæ*. And while the section *Acaste* is chiefly Lower Silurian, and *Chasmops* wholly so,—the large flattened species which form this group, with their numerous tail-segments, are almost all Upper Silurian. They commence, so far as I know, in the May Hill Sandstone. The most renowned of them all is the *P. caudatus*, and it is at the same time the most typical.

I commence with those species in which the caudal portion is least extravagantly developed:—

PHACOPS (ODONTOCHILE) OBTUSICAUDATUS, *Salter*. Pl. I, figs. 42—45.

PHACOPS OBTUSICAUDATUS, *Salter*, in Sedgwick and M'Coy's Synopsis Foss. of the
Woodw. Mus., pl. i G, figs. 15, 16.

— — — *Id.* Mem. Geol. Survey, Dec. II, pl. i, p. 7, note.

P. (Odont.) uncialis, capite elongato semielliptico tuberculato; caudá brevi. Glabella longa, lobo antico magno rotundato, lateralibus subæquis, radiatis, sulcis longis profundis. Oculi elongati, antici. Genæ angustæ scrobiculatæ, spinis modicis. Cauda trigona, apice angulato, axe rotundato longo 12-annulato; lateribus recti-sulcatis, sulcis 10, omnibus duplicatis; margine angustissimo.

This is known only in one locality; but it is a common fossil there, and is accompanied by but very few other fossils. It is a gregarious species, occurring in crowds upon the faces of the "bated" or cleaved rock in Coldwell quarry, Westmoreland.

The head is half elliptical, frequently an inch and a half long, the width then being

about two inches; the general form that of a pointed arch; the glabella narrowed, long-oblong, not much broader in front than behind, the forehead-lobe as long as the rest of the glabella (including the prominent neck-segment), and almost *round*. The side-lobes are very strong, and divided by deep, radiating furrows, deepest and strongest inwards, and reaching far towards the centre. The upper lobe trigonal, not greatly larger than the mid-lobes; the basal lobe narrow, almost linear externally (and clavate in the cast). The whole glabella covered by coarse tubercles and fine granules intermixed.

The eyes are large, reniform, elongate, compressed laterally instead of longitudinally, and placed in advance of the centre of the cheek, half their own length from the neck-furrow, and touching the glabella in front. The cheeks curve steeply down, are scrobiculate, not tubercular, margined nearly all round by the narrow furrow, and provided with head-spines half as long as the glabella.

The facial suture curves largely forward outside the eye, and cuts the margin about half-way up the cheek.

We have no body-rings. The tail is broadly triangular, pointed below, but not produced into any mucro, and with a very narrow equal margin. The conical and very convex axis nearly reaches the tip, annulated all the way down, and has about twelve sharp rings. The sides are strongly radiated; nine or ten strongly duplicated ribs running on each side to the narrow margin. The intermediate furrows are straight at their origin and terminations, and at the latter point they are so deep as to make the margin pretty strongly undulate.

Locality.—CARADOC SLATE of Coldwell, Westmoreland; in beds over the Coniston limestone. [Brit. Mus. Mus. P. Geology. Woodwardian Museum, &c.]

PHACOPS (ODONTOCHILE) MUCRONATUS, *Brongn.*? Pl. IV, figs. 11, 12.

[ENTOMOLITHUS, *Linnæus*. *Iter Vestrogoth.* p. 88, *cum fig.* 1747.

ENTOMOSTRACITES CAUDATUS, *Wahlenberg*. *Nova Acta Reg. Soc. Upsal*, tom. viii, p. 28, t. ii, fig. 3, 1821.

ASAPHUS MUCRONATUS, *Brong.* *Crust.*, p. 24, t. iii, fig. 9, 1822.

— — *Dalman*. *Palæadæ*, p. 236, t. ii, fig. 3, *a, b*, 1826.

— — *Hisinger*. *Lethæa Suecica*, p. 13, 1837.

PHACOPS — *Emmrich*. *Dissert.* (1839); *Neues Jahrbuch*, 1845.

— — *Angelin*. *Palæont. Suecica*, tab. viii, fig. 1, 2, 1852.]

— — *Salter*. *Decade VII*, Art. 1, p. 12, 1853.

P. triuncialis et supra. *Glabella convexa, antice parum dilatata, utrinque lobis tribus subæqualibus transversis, sulcis longis satisque profundis sese separatis. Cauda triangularis acuta; axe convexo limbo plano haud æquali, in annulos 9 et appendicem diviso [appendice in apicem caudæ brevimucronatum percurrente?]; lateribus costis 8 planis, sulcis 7*

angustis acutis valde curvatis et cum tot lineis intermediis profundioribus ad apices confusis ; margine angusto subundulato.

From the number of authors who have described the Swedish species, it must be a common one, and yet there is no good figure extant. Angelin's, the latest, is worse than Dalman's, which appears to be the best, for Wahlenberg's figure is so very unlike the fossil that, were it not for his description and statement of locality, it would be impossible to recognise it. Brongniart has only copied Wahlenberg, who appears to have been chiefly attentive to the course of the facial suture, and allowed his artist to take his own course.

To make evident the distinctions between our British fossil (which is certainly very nearly allied to the Scandinavian one), and the true *P. mucronatus*, I subjoin a figure from one of Sir R. I. Murchison's specimens.

It will be seen readily that the head we here figure has less regular and equal lobes than the British one, and this is a character of high importance in the family. And the tail, while it has a great resemblance, has not the strongly curved and deeply impressed ends to the side furrows, which give so conspicuous a character to our fossil. I am justified, therefore, in placing a ? against the same: indeed, had it not been already referred in the Decades to *P. mucronatus*, I would have preferred keeping it distinct under the name *P. appendiculatus*. For the present I leave it in doubt.

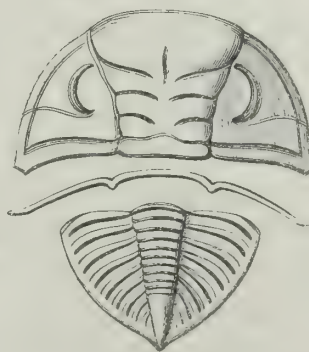
Description. Our specimen of the head only shows a broad glabella with three equal pairs of lobes, which are divided by nearly straight somewhat radiating furrows: the two lower pair of lobes are linear and direct; the upper somewhat clavate, but not triangular, and separated by a slightly sinuous furrow from the wide transverse forehead-lobe. All the lobes are tumid; and a convex median ridge, of equal breadth throughout, divides the lobes of one side from those of the other. A deep central pit in the cast occurs upon the forehead-lobe, as in many species.

Of the triangular tail we have more complete evidence, though even of this only a fragment.

The axis is broad and convex, of nine strong rings, and a terminal portion or appendix, of which we do not know the length. While the axis is convex, the sides are very flat, have the forward edge strongly curved, and are deeply grooved by seven arched duplicated furrows. The backward curve of these near the margin is considerable, and the secondary furrows are as strong or stronger than the primary, and coalesce with them at the tips in deep grooves, so as to undulate the very narrow margin considerably.

* "*Loc. Nat.* In stratis argillaceis E, Vestrogothiæ, in montibus Alleberg et Mössberg, alibique." Angelin, '*Palæont. Suecica*,' part 1, 1852.

FIG. 10.



Swedish specimen of *P. mucronatus*.
Lower Silurian; Alleberg Mountain,
Vestrogothia.*

Locality.—CARADOC SLATES of Pen-y-Rhiw, west of Bala, over the volcanic ash-bed. (Mus. Pract. Geology, figs. 11, 12.) The other locality given in the Decade above quoted is erroneous; the specimen referred to is a species of *Ogygia*, which will be figured further on.

PHACOPS (ODONTOCHILE) IMBRICATULUS, *Angelin*? Pl. IV, fig. 10.

[PHACOPS IMBRICATULUS, *Angelin*, Palæont. Suec. t. vii, fig. 5, 1852. ?]

This I do not wish yet to name. It is a new British species, but scarcely perfect enough to assure me it is not the same as one of Green's published casts.

The pygidium is seven-eighths of an inch long, excluding any mucro it may have possessed, and the width about one and a half inch. It is rather flat, the centre raised in a low pyramidal form, and the sides sloping outwards and gently curved down near the very narrow, regular, smooth margin. We have two specimens, in both of which the axis is not one fourth the entire width at tip; it is regularly conical to within a very short distance from the margin, annulated by about twelve or thirteen flattened rings, and has an appendice beyond, as far as the prominent tip; the rings of the axis are angulated forwards. The axial furrows slight but distinct, the pleural furrows on the side-lobes widely patent, and nearly straight, except a slight angular backward bend near their abrupt ends. There are ten lateral ribs, all strongly duplicate to their very tips; the intermediate furrows not keeping quite separate, but combined at the ends, and nearly as strong as the principal ones. This strong duplication gives a very striking character. The incurved margin is regular and narrow all the way round.

It is very like *P. mucronatus* from Sweden; but perfect specimens of that species (see woodcut, supra p. 47) show that species to have had a narrower tail with wider margin, and the head is flattened, with arched lower glabella-lobes. It must be distinct. But the *P. imbricatulus*, on the other hand, is quite like ours; it has ten dichotomous side-ribs, and a very distinct margin. The axis has ten distinct, and five or six terminal joints. The tail is mucronate. Altogether it is very like our species.

Locality.—MAY HILL SANDSTONE (UPPER LLANDOVERY), of Nash Scar, Presteign, collected by Mr. J. E. Davis, of the Middle Temple. (Mus. Pract. Geology.)

PH. (ODONTOCHILE) CAUDATUS, *Brünnich*. Pl. III, figs. 4—18, and Pl. IV, figs 1—5, including varieties.

TRILOBUS CAUDATUS, *Brünnich*. Kjobenh. Selsk. Skrifter, Nye Samml., vol. i, p. 392, 1781.

— — *Schlotheim*. Nachträge, 35, 11, 1823.

ASAPHUS — *Brongniart*. Crust. Foss., t. ii, fig. 4 (not iii, fig. 9), 1822.

— — *Dalman*. Palæadæ, t. ii, fig. 4, 1826.

— — *Green*. Monogr. Tril. N. Amer., cast 17, 1832.

— — *Buckland*. Bridgw. Treat., pl. xlv, figs. 9—11, 1836.

— — *Murchison*. Sil. System, pl. vii, fig. 8 a; and *A. tuberculato-caudatus*, *ibid.*, fig. 8 b, 1837.

— — *Milne-Edwards*. Crust., vol. iii, p. 308; and *A. tuberculato-caudatus*, 1840.

— MYOPS, *König*. Icones Sectiles Foss., fig. 53, 1825 (our Pl. III, fig. 13, is from the original specimen in the British Museum).

PHACOPS CAUDATUS, *Emmerich*. Dissert., 1839.

— — *Goldfuss*. Neues Jahrb., 1843.

— — *Burmeister*. Org. Tril., 2nd edit., t. iv, fig. 9, 1846.

— — *Salter*. Decade ii, Geol. Surv., 1849 (exclude syn. *P. longicaudatus*), pl. i, figs. 1—12, and fig. 15.

DALMANIA CAUDATA, *Emmerich*. Neues Jahrbuch, 1845.

— — *Salter*. Memoirs Geol. Surv., vol. ii, pt. 1, 1848.

ODONTOCHILE CAUDATA, *M'Coy*. Synopsis Pal. Foss. Woodw. Mus., p. 160, 1851; Pl. III, figs. 4—17.

Var. α, VULGARIS. Most of the above synonyms, Pl. III, figs. 4—17.

Var. β, TUBERCULATO-CAUDATUS, *Murchison*. Pl. IV, fig. 1.

Var. γ, NEXILIS, *Salter*. Pl. IV, figs. 3—5.

Var. δ, ACULEATUS, *Salter*. Pl. III, fig. 18.

P. (Odontochile) magnus, 3—4-pollicaris; ovatus, sub-convexus, capite angusto, fronte plus minusve angulato. Oculi magni, pyramidati. Pleuræ sulcatæ (fulcro ad dimidium posito) posticæ recurvæ. Cauda apice brevi-mucronato, axi 11—12-annulato; costis lateralibus 7, rarius 6, arcuatis, duplicatis, ad marginem lævem abruptè terminatis, recurvis.

Four of the varieties are here figured, and I have no doubt there are others. Those selected illustrate the very close connection that exists between this fossil and the so-called species *P. longicaudatus*.

In the Decade of the Survey above quoted I ventured to unite these two species, and have still little doubt that the series of figures here given will convince naturalists that all are derived from one stock. But it will not be so easy to convince paleontologists; and

as there really are definite characters on which we can rely, it is thought best to follow the general practice, and describe them separately.

The cabinets of Dr. Grindrod, of Malvern, Mr. E. Hollier, Mr. Tennant, Mr. Mushen, and the British Museum, have furnished the chief materials.

Description.—Four or five inches long; ovate; length as to width varying from 10 to 6, to $8\frac{1}{2}$ to 6; gently convex; the thorax longer than either head or tail; the latter about equal to the head, excluding the produced mucro; axis of the body much more than half the width of the sides.

Head semicircular, exclusive of the slightly produced front or the long stout posterior horns, which are broad at the base and reach the seventh or eighth thoracic ring. Glabella coarsely tubercular, widened above, more than one third the width of head; the forehead-lobe a transverse rhomb, separated from the upper side-lobes by deep, broad, oblique furrows, which nearly meet; the lateral lobes and neck-lobe all nearly equal in width, and together equalling the forehead-lobe; the first and second lobes run straight across, and leave but a narrow ridge down the middle; strong axial furrows separate the glabella from the triangular cheeks, on the surface of which the large pyramidal eyes occupy a variable extent; a lunate depression surrounds their outer edge, and this is sometimes extended over more than half the width of the cheek, sometimes barely half, giving a considerable difference in appearance. The length of the eye, which is sharply curved, is uniformly from the first basal furrow to the middle of the upper one; eyelid with a deep concentric groove; lentiferous surface considerably broader forwards; lenses about 240, 8 or 10 in a vertical row. In several perfectly preserved specimens the cornea is present, and it is distinctly convex over each lens, the intermediate surface being ornamented with tubercles and granules, so as to leave no doubt of its being the true exterior; it is, too, continuous with the other portions of the preserved shell. The cornea does not rise, as in some other species, into elevated ridges between the lenses, but is flat in some specimens, in others it sinks down between them. Occasionally a lens (or two) is undeveloped and very small, among other perfect ones. The facial suture exactly circumscribes the glabella in front, falls perpendicularly to the eye, and arches outwards and upwards from its lower angle to the outer margin of the head, on the lower face of which it extends along the margin further back than on the upper surface (Pl. IV, fig. 4). The cheek-pieces are united in one (as in all the genus) across the front, and there is no extra piece (or rostral shield) inserted between them above the labrum.

The latter is parabolic, obtusely pointed, the sides a little waved, and the base of attachment extended; a transverse furrow within the lip is connected with a marginal longitudinal one on each side; a pair of lateral strong indentations indicate a second furrow above.

Round the head a strong furrow separates a broad margin, but ceases at the base of the spines, and there nearly meets the equally strong neck-furrow, which is arched down at its end. The margin in front of the head is more or less produced into an obtuse point.

Thorax with the central lobe not separated by any strong furrow from the pleuræ, which in English specimens are half as wide again as the axis; the axis is a little fusiform, not broader than the base of the glabella, and either has the rings smooth, tubercled at their outer edges, or with two tubercles on the central prominent part. All these variations occur on the same thorax. The front pleuræ are flat for the first half, then gently curved down, and a little backwards, at the fulcrum; they are divided by a moderately strong curved furrow for most of the length, and their edge sharpened anteriorly (the flat surface not crossing the furrow, as in *Acaste*), for rolling or bending. The extremities are truncate, and pointed at the hinder angle; posterior pleuræ with the fulcrum at less than half, much more curved back and strongly pointed, overlapping the upper corners of the tail. Whole surface of thorax finely granular.

Tail with the sides meeting below at nearly a right angle, and produced more or less to a sharp point beyond this; axis not much raised, and gently tapering, ending a little abruptly at some distance from the point; it has eleven or twelve ribs, which are occasionally tubercular, like the thorax, sometimes much so; the sides have six, seven, or sometimes eight narrow ribs, strongly arched down at their ends, where they abut suddenly on the smooth margin; each is sharply defined behind, and duplicated on its forward edge by a fine rib along its whole length. The number of ribs appears to be as great in the young trilobites as in the adult form.

The above description, extracted from the *Decade*, will serve for the general account of the species. I distinguish the following varieties more particularly.

VAR. *a*, VULGARIS. Pl. III, figs. 4—17.

Form narrow-ovate. Head broad, rounded, or slightly angulated only in front. Glabella as broad as the cheeks. Tail truly triangular, simply pointed, scarcely at all acuminate.

There is no essential difference between any of the specimens of this common variety. All have the rounded or arched front margin (not at all produced) to the head; the glabella at its widest part much more than one third the whole width of the head. The length of the head as near as possible half the width of the same; the axis broad; the tail shorter than the width, and simply pointed, with a very short mucro, or none at all.

They vary a little among themselves in the following particulars. Some have the glabella more strongly marked out, and more decidedly narrowed behind. Some have the glabella-furrows a little deeper. The eyes are larger in some (as in the varieties of *P. Downingiæ*, before described), and more prominent; but I have elsewhere referred these differences to sex. The male had probably more prominent eyes.

Some specimens have the characteristic tubercles on the sides of the axis, and the central ones on the tail much stronger than others. We have figured these tubercular varieties in Pl. III, figs. 15—17. As these seem to be chiefly characteristic in the young state, and are much more obscure in the full-grown animal, I will here notice them particularly as they occur in the young and older states.

Young specimens. Pl. III, fig. 15; Pl. IV, fig. 2 (see also Decade 2, Geol. Surv., pl. i, fig. 7).

These differ in several particulars from the adult. The head-spines are smaller in proportion, and the head-margin very narrow. The tail, too, is much smaller proportionally, and more pointed, even mucronate, the mucro being in some cases nearly as long as the tail.* The sides of the tail have fewer ribs, and the axis is not so strongly marked out as in the adult.

In the very neat and characteristic young specimen, Pl. III, fig. 15, while the general character of var. α is preserved, it is in some respects like the var. γ , hereafter described.

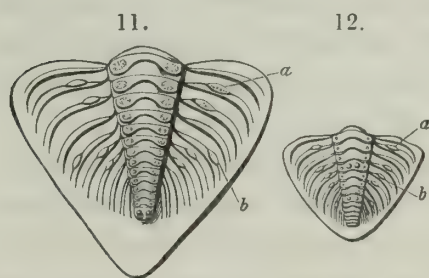
Surface-ornaments and Tubercles.—The tubercles of the surface are larger in proportion in the young specimens. On the axis they are particularly strong. In one of Mr. Mushen's specimens (supposed to be a distinct species by De Koninck, and called by him *P. Mushenianus*, MS.), the second, fifth, and eighth thorax-rings are ornamented by a pair of tubercles, the fourth and seventh rings of the tail-axis, and the first and fourth lateral ribs. Our figured specimen (Pl. III, fig. 15) has the same ornaments, but they are too small to be shown in the figure. This central double row of tubercles is very conspicuous, and must surely have some special meaning. On all the young specimens a distinct central space is marked out by these pairs. On all, the forehead-lobe of the glabella has one pair wide apart and one pair more approximate. Each of the hinder lobes of the glabella has a pair (in one of Mr. Mushen's fossils even the front head-margin has a pair).

Then, as before stated, the second, fifth, and eighth thorax-rings show them—the fourth, seventh, eighth, and twelfth of the tail, &c. And so we get a median line of double tubercles, which are only more conspicuous in the young because in these the tubercles of the general ornamented surface are not so large; and consequently these, which do not much increase in size as the animal grows, lose their importance, so far as the exterior is concerned.†

But that these tubercles are of real significance in the structure of the animal is evident enough, if we examine the fine interior cast figured in Pl. III, fig. 12. I have reproduced this specimen in the woodcut (fig. 11), and also the exterior of the tubercular variety (fig. 12), which is the same specimen

FIGS. 11, 12.

Symmetrical cutaneous glands in the crust of
P. caudatus.



11. Interior cast from Ledbury.

12. Exterior of Malvern specimen. Both in Mus. Pract. Geology.

* This character is in ordinary cases eventually lost, the mucro not growing in proportion to the rest; but occasionally it is preserved, as in var. δ , *aculeatus* (Pl. III, fig. 18).

† M. Barrande has specially noted the same fact, with regard to the *Sao hirsuta* of the Bohemian basin.

as that given in Pl. III, fig. 17. It is from Malvern, as is also fig. 16, with the same prominent ornament.

Here, in this full-grown and very large specimen, it is shown that not only are the tubercles more than superficial ornaments, for they are distinctly marked out by shallow oval pits within the crust, but that they are actually far more numerous within, a pair occurring in fig. 11 on every joint of the axis. It will be observed that they occur in the adult in precisely the same relative position as in the young, viz., externally at intervals on the axis, and on the second, third, fifth, sixth, and seventh lateral ribs, or rather on the intermediate duplicating furrows of these ribs.

Their position on the side ribs is remarkable. The first pair *a*, occur on the second rib about half way out; the next pair closer in to the axis. In like manner those on the fifth segment *b*, are far out, and those on the two succeeding ribs gradually close in. This regularity of position should be taken into account, as it indicates that there is some structural importance in them.*

Var. β , TUBERCULATO-CAUDATUS. Pl. IV, fig. 1.

PHACOPS TUBERCULATO-CAUDATUS. *Murchison*, Sil. System, pl. vii, fig. 8 *b*, 1837.

— CAUDATUS. *Siluria*, 2nd ed., pl. xviii, fig. 1, 1839.

Form broad-ovate. Head decidedly angulated in front. Glabella not so wide as the cheeks. Tail triangular, pointed, and a little produced.

Comparing this with the ordinary variety, we find that the principal differences reside in the generally broader form, the length being to the breadth about as 6 to 4, or rather longer. This excludes the extreme mucro, which is broken off in our largest specimen.

Besides this, the margin of the head is broader, and more sharply distinguished from the head by a deep marginal furrow. The glabella is somewhat narrower and shorter, with few large tubercles. The eyes quite as large and conspicuous as in the larger-eyed forms of the ordinary variety, and which I suppose to be the male (σ), and the front is more angular; it is produced, but not nearly to the extent of the anterior mucro in the next species, *P. longicaudatus*.

The thorax has remarkably large tubercles on the axis, and a central pair on the second ring, and the pleuræ on this specimen are tumid at their origin.

The axis of the tail is short and rather flat, and the side lobes have seven or eight very prominent ribs; on the fourth, fifth, and sixth of which the remarkable gland-like tubercles show strongly. The upper one on the first rib is not so prominent. The tail is strongly margined, and the mucro (broken off) must from its shape have been short and rather suddenly acuminate.

* They are occasionally even more numerous than here indicated, occurring as tubercles on several of the lateral segments of the body-rings, as well as on those of the tail (specimen in Mr. Edgell's collection), see also Pl. III, fig. 23.

These are all the characters that appear to me worthy of note in this fine variety. I think the large specimen figured by Murchison must belong to it; the tubercles are arranged in the same fashion. But, the front being broken off, it is not quite certain. Nor do I know where to find that specimen.

Locality.—WENLOCK LIMESTONE, Dudley? (Murchison); LOWER LUDLOW, Ledbury Tunnel (Dr. Grindrod's cabinet); Dudley Tunnel (Mr. Edgell's collection).

Var. γ , NEXILIS. Pl. IV, figs. 3—5.

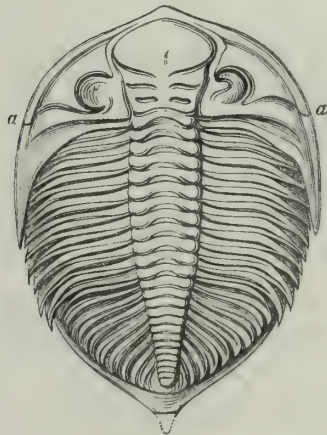
P. CAUDATUS, Salter, Decade Geol. Surv., ii, pl. i, figs. 10, 11, only.

Form broad-ovate. Length to width as eight and a half to six. Head arched, obtusely pointed in front, and more than twice as wide as long. Glabella very narrow, not nearly one third the width of the head. Tail broad-acuminate, not produced, its axis very narrow.

This neat variety was figured in Decade 2 of the Geol. Survey, but does not seem to have been specially noticed by any author. It is not very common, except at one locality, where it is in profusion. At Vinnal Hill, Ludlow, the fine mudstones of the Lower Ludlow Rock are full of this trilobite.

It is remarkable for the narrow axis to the head, a good deal resembling in this particular the next species, but differing entirely in the extremely short general form, which is rounder than even the common variety, and with scarcely an angular, much less a mucronate, front.

FIG. 13.



P. caudatus, var. γ , *nexilis*, Lower Ludlow, near Ludlow. Mr. W. Edgell's cabinet.

The forehead-lobe is large in proportion to the others; the upper lateral lobe not much larger than the rest; and the tail, abruptly acuminate, and very broad for the species, has a very narrow axis, like the next species. The side-lobes are marked by the usual seven curved ribs, strongly duplicate.

Our Pl. IV, fig. 4, is the same specimen as that figured in the Decade 2, pl. i, and shows the true shape of the first or front ring, bearing the eyes in this subgenus. The narrow ribband-like band in front of the glabella is all on the upper surface, not, as in the previous subgenera, marginal, or beneath the margin.

This last variety brings us very near to the characters of the *P. longicaudatus*, but has still the abrupt, not the mucronated, front. And while the axis is very narrow, the general shape is rounder, instead of longer, than the ordinary forms.

Var. δ , ACULEATUS. Pl. III, fig. 18.

I have before referred to this rather uncommon form (p. 52, note).

Localities.—[It has been quoted from Lower Silurian rocks, by myself (the Caradoc strata of Robeston Wathen and Narberth, in Pembrokeshire, for instance); but I do not know that it really descends below the MAY HILL SANDSTONE.]

MAY HILL SANDSTONE (or Upper Llandovery, Murchison), Dingle, Ireland; Barr, Walsall. WOOLHOPE LIMESTONE and SHALE, Malvern; Presteign; Woolhope; Walsall, and from the DENBIGHSHIRE GRITS of N. Wales. WENLOCK LIMESTONE and SHALE; the Malverns; Shropshire; North and South Wales, everywhere; Westmoreland; Dingle, &c. LOWER LUDLOW and AYMESTRY LIMESTONE of Shropshire and Herefordshire; of Dudley Tunnel; of Malvern. UPPER LUDLOW, Ludlow; rare in this formation (R. Lightbody).

The above are localities in general for the common variety. Var. β is found in WENLOCK LIMESTONE (Murchison), and our figured specimen from LOWER LUDLOW, Ledbury tunnel, in Dr. Grindrod's cabinet. Var. γ is only known as yet in LOWER LUDLOW rocks, and specially at Vinnal Hill, Ludlow (Mus. Pract. Geol.); also at Newton, in the same neighbourhood (Mr. Edgell's cabinet). Var. δ is from Dudley.

PHAC. (ODONTOCHILE) LONGICAUDATUS, *Murch.* Pl. III, figs. 19—28.

TRILOBITE WITH CAUDAL PROCESS, *Parkinson.* Organic Remains, vol. ii, t. xvii, fig. 17, 1811.

ASAPHUS LONGICAUDATUS, *Murchison.* Silur. Syst., pl. xiv, figs. 11—14, 1837.

— — — — — *Milne-Edwards.* Crustacés, iii, 308, 1840.

PHACOPS LONGICAUDATUS, *Emmerich, Goldfuss, &c.* Loc. cit., 1845, 1846.

— MUCRONATUS, *Burmeister.* Org. Tril., t. iv, fig. 9 (exclude synonyms), 1843, and ed. 2 (Ray ed., 1846).

— CAUDATUS, β LONGICAUDATUS, *Salter.* Decades Geol. Survey, ii, pl. i, figs. 13, 14.

Var. α , ARMIGER. Pl. III, figs. 19—21 (*P. longicaudatus* of authors).

Var. β , GRINDRODIANUS. Pl. III, figs. 22—28, new variety.

P. (Odontoch.) medius, 2—3-pollicaris, ovatus elongatus subconvexus, capite lato, fronte mucronato. Oculi maximi. Pleurae sulcatae recurvae, fulcro ad dimidium. Cauda trigona longimucronata; axe 15—16-annulato, ad apicem haud eminente; costis lateralibus 7 arcuatis, duplicatis, ad marginem laevem abruptè terminatis, recurvis.

Distinguished easily at a glance from the more common *P. caudatus* by the greatly elongate tail, but much less distinct when closely examined, since the general habit and even the minute structure is similar to that of the Wenlock species.

In all the specimens I have seen (and there are few perfect ones extant of the long-tailed species) the following differences are observable:—1st. The axis is invariably narrower, not one third the width of the head, always quite as much so as in the *P. caudatus*, var. *newilis*, which differs from the other varieties in this particular, and yet has less trace of a mucronate front than any of them. 2nd. The abrupt mucro (not mere angulation) to the front. 3rd. The smaller tail, with more arched furrows. 4th. The

great terminal mucro, always equal to the length of the tail itself, and often half as long again.

There is evidently, however, a nearer connection between the var. β . (*Grindrodianus*) from Malvern, and the var. γ of the last species. But while in this variety β , which comes nearest to *P. caudatus*, the mucrones of the head and tail are shortened, the narrow axis still easily distinguishes it from the varieties of that species; and the variety γ , *nexilis* of the *P. caudatus*, which has really a narrow axis, has nearly lost all trace of the processes, and has scarcely a mucro at all. It is not difficult, therefore, to distinguish the two species.

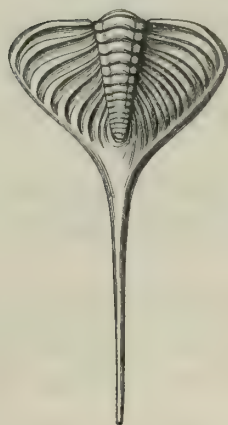
Description.—Full-grown specimens must have been fully six inches long, including the tail. The form is elongate, and less convex than in *P. caudatus*. In both varieties the head is less than twice as wide as its length, but is still transverse in shape, its glabella scarce one third the whole width. The glabella at its front part is parallel-sided. Forehead-lobe transverse-oval, well separated from the side-lobes, which are tolerably equal,—the upper one not greatly largest. Eyes large, pyramidal, and placed very near the glabella, so as almost to touch it in front, and strongly curved,* reaching below to the neck-furrow, and often overhanging it.

The axis of the body and tail narrow in proportion to the sides, sometimes not one fourth the width in the body-rings, and barely one fifth in the tail. The surface of the body-rings is tubercular. Hinder pleuræ much bent back. Fulcrum at about one half. Pleural groove shallow, ending in a point beyond the fulcrum. Tail small in proportion, with few (5—7) side-furrows, much curved and strongly interlined. Mucro abrupt, linear, as long or longer than the rest of the tail. The gland-like tubercles sometimes present, but often inconspicuous throughout.

The above characters are common to the two following varieties.

Var. α , ARMIGER: Pl. II, figs. 19—21.

FIG. 14.



Head, including the strong front mucro, much more than half as long as wide. Glabella not one third the width of the head. Marginal furrows strong. Head-spines as long as the cheek. Mucro of tail much larger than the rest of the tail; side-furrows 7.

I figure a remarkable specimen from Mr. Edgell's cabinet, in which the spine is considerably more than twice the length of the axis, and is expanded at the tip, more than is shown in our woodcut.

One specimen of Dr. Grindrod's shows clearly the passage from this form to the next variety, *P. Grindrodianus*, having the mucro quite as long as usual, but having only five lateral ribs, and tubercles on the axis and sides. Usually *P. longicaudatus*, var. *armiger*, shows seven lateral ribs, and has no distinct tubercles.

* Much more so than in *P. caudatus*.

Localities.—Var. *a*, WOOLHOPE LIMESTONE, Presteign; WENLOCK SHALE of Cheney Longville and Burrington, Shropshire (abundant); Usk, Monmouthshire; also Carmarthen-shire, Brecon; and Marloes Bay, Pembrokeshire, more rarely. It is quoted also from WENLOCK LIMESTONE, Malvern, in the Survey lists.

Var. *β*, GRINDRODIANUS. Pl. III, figs. 2—28.

Head, including the short front mucro, somewhat more than half as long as wide. Glabella, at its widest, not more than one third the width of the head. Forehead-lobe prominent. Tubercles on head, body, and tail, conspicuous. Tail with few (5—6) side-furrows, and about ten axial rings; the spine not more than equal to the rest of the tail.

This variety, of which we fortunately can examine a fine suite of specimens, differs from the typical form in points which do not affect the specific characters given above. It is only less extravagantly armed,—the front, rear, and side-spines being all shorter. The side-spines reach to the seventh segment. The surface shows the tubercles characteristic of the young,—in the adult state; both on the forehead-lobes and the lower lobes of the glabella, on the axis of the body,¹ and on the fourth and eighth segment of the axis of the tail. The gland-like tubercles on the fourth side-pleuræ are not always conspicuous.

The mucro is shorter, seldom equalling the tail itself in length. The side-ribs are five, strongly duplicate to the very end, and the margin very narrow.

Locality.—Var. *β*, WENLOCK SHALE. It is known only at Malvern Tunnel and Dudley.

PHACOPS WEAVERI, *Salter*. Pl. III, figs. 1—3; Pl. IV, figs. 6—9.

PHACOPS WEAVERI, *Salter*. Decades Geol. Surv., ii, art. 1, p. 7, pl. i, fig. 16.

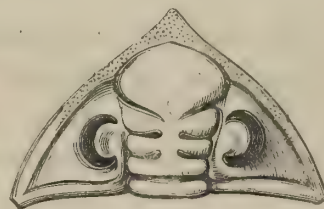
— — — *Id.* Morris's Catal., 2nd, ed., p. 114, 1854.

P. lævis, capite quam in *P. caud.* nisi trigono lobisque glabellæ tumidioribus. Cauda triangularis, fere æquilatera, multicostata, convexa, apice acuto brevimucronato; axi 13—16-annulato, costis lateralibus 10—12 simplicibus, vix curvis, ad marginem angustum abruptè terminatis.

We know but little yet of this fossil. It is fragmentary as yet; and though I believe the specimens here figured all belong to one species, I would prefer to keep the name for the fossil of the May Hill Sandstone.

The head is very imperfect; what there is of it strongly resembles *P. caudatus*, except that the lobes are a little more tumid; the forehead-lobe is more strongly marked

FIG. 15.



Head of *P. Weaveri*? Canada.²

¹ It seems that when the tubercles exist on the sides of the axis, they are not present towards the centre, and *vice versa*. But it is not every segment which has the tubercles at all.

² I have good reason to believe this Canadian species, brought by Sir W. Logan from Ile Percè,

off, and somewhat overhanging the side-lobes. The eye does not reach the neck-furrow.

The tail is broad-triangular, wider than long; the sides a little convex; the apex short-mucronate; the axis narrow, conical, ribbed by about sixteen rings; the sides very convex, with nine to ten arched simple ribs, scarcely at all interlined; the margin narrow, smooth.

Locality.—MAY HILL SANDSTONE, "Long's Quarry, Damory Bridge, Charfield, and Woodford Green, Tortworth;" (Decade 2, Geol. Surv., p. 7).

Figs. 8, 9, show a variety with ribs slightly duplicated on the interior cast, but with a short mucro. It is from Marloes Bay, Pembrokeshire (Mus. Pract. Geology).

Larger form of the species.

Pl. III, figs. 2, 3.

The large caudal shields here figured clearly belong to a species distinct from *P. caudatus*. They are one and a half inch long, and probably reached two inches in width when perfect. The general form agrees well with that above described, and it has the numerous, slightly curved ribs, scarcely duplicated at all, and with the interstices deeply concave. They are very little bent at the extremities. Our fig. 2 is better in this respect than fig. 3. The margin is equal and narrow all round.

P. imbricatus of Angelin has ten dichotomous side-ribs, and a very distinct margin; else it is not unlike our species.

Locality.—LUDLOW ROCKS? Horseshoe Farm, Tortworth. It is possible there is a boss of MAY HILL SANDSTONE at this place.

Section—CRYPHÆUS (p. 15).

This subgenus alone would decide against the folly of classifying Trilobites by such a character as the pattern of the tail. All the species known in Europe or North America are allied to *Odontochile*, and follow naturally that subgenus. But in the southern hemisphere we have compact forms allied to *Acaste*, which have the tail spinose.

Gaspè, Lower Canada, to be identical with ours. The tail is a little more mucronate. The head agrees nearly with our fragments, and will at all events give collectors a good idea of the probable shape. It is remarkably triangular, even for this subgenus.

PHAC. (CRYPHÆUS) PUNCTATUS, *Steininger?* Pl. I, figs. 17—19.

OLENUS PUNCTATUS, *Steininger*. Mém. de Soc. Géol. Fr., i, p. 356, vol. i. pl. 22, 1833.

— — *Emmerich*. Dissertation, p. 55, 1839.

ASAPHUS ARACHNOIDES, *Goldfuss*. Leonhard und Bronn's Neues Jahrbuch, p. 561, tab. v, fig. 3, 1843.

CALYMENE — *Höninghaus*, pamphlet, Crefeld, 1835.

PLEURACANTHUS ARACHNOIDES, *Milne-Edwards*, Crust., iii, p. 329, 1840.

— PUNCTATUS, *Roemer*. Rheinisch Uebergangs., p. 82, 1844.

PHACOPS ARACHNOIDES, *Burmeister*, Org. Trilob., 1st ed., 1843; 2d ed., p. 96, 1846.

— LACINIATUS, *Salter*, in Morris's Catalogue, 2nd ed., p. 113, 1854 (not of *Roemer*).

Phacops (Cryphæus) "scuto capitis in medio marginis antici acuto, angulis posticis valde productis; limbo scuti caudalis decies spinosa."—*Burm.*, l. c.

The only notices I can find of this as a British species are by myself—first, in the Decades of the Survey, No. 2, under the description of *P. caudatus*, p. 8, where it is referred to *P. arachnoides* of Goldfuss; and afterwards in Morris's Catalogue, 2nd ed., 1854, where it is referred, I think wrongly, to *P. laciniatus*, Roem. The fragments known were so very obscure, that enough could only be seen to make it certain we had one of the species of this remarkable group, in which the tail-margin has undergone its fullest expansion.

In order to give the English collector a notion of what he may expect to find, I have drawn a perfect specimen from Germany, nearly following Burmeister. And, after comparing with the best specimens at my command, I think the first reference was right, and that the British species is the well-known, but still rarely perfect, *Olenus punctatus* of Steininger, a name which should have been retained for this fossil, as Steininger's figure is quite recognizable.

I purposely avoid describing the British fragments, as the inspection of the plate will show that they only indicate a species with narrow, long glabella, with tolerably equal lobes, a granulated surface, a pointed front to the head (not produced, however, as in the foreign specimens), and longer head-spines than in the German specimens. The eyes appear to be not quite so large.

The tail shows ten spines, which are rather shorter, less convergent, and more radiating than Eifel specimens warrant.¹ But they are narrow, not broad, fin-like plates, as in *P. laciniatus*, and longer, too, in proportion than in that species; the glabella, too, is nar-

FIG. 16.



Phacops (Cryphæus) punctatus, Stein.,
from Burmeister's work.

¹ Goldfuss's figure is more faithful than Prof. Burmeister's.

rower and more pointed, and the lobes less crowded. It need not be compared with *P. stellifer*, Burm., as that species has eleven broadish spines.

We must wait a little for more perfect information.¹ It is certain that a very beautiful Trilobite is yet to be found in Cornwall and South Devon, and collectors should look carefully for it.

Locality.—MIDDLE and LOWER DEVONIAN. Torquay, South Devon; Slates of Liskeard, Cornwall (Coll. Mr. Pengelly and Mus. P. Geology).

FAMILY—CHEIRURIDÆ.

A group whose limits are not yet fully defined, if, as I suppose, it should include all the forms cited below. The Cheiruridæ proper have really more of the characters of the Phacopidæ than appears at first sight, for these loosely built Trilobites have the eyes reticulate externally, though on a smaller scale than *Phacops*, and the facial suture ends upon the exterior, not the posterior, margin. The normal number of body-rings is eleven. With these points of resemblance, important as they are, the analogy ceases, for the short, oblique furrow and free ends of the nodular pleuræ give a very marked aspect; and the tail is of few joints, and the ends of their pleuræ are also free.

The genera thus included are *Cheirurus* proper and its subgenera, and *Sphærexochus*, with *Amphion* and *Placoparia*.² *Staurocephalus* and *Deiphon* must follow these.

But the other group, *Encrinurus*, *Cybele*, *Cromus*, *Zethus*, &c., though they agree in the marked position of the facial suture, have so many differences of habit that I am doubtful if they should not form a distinct family. The long prominent eyes may or may not be granulated; we have no evidence of it. But there is a strong resemblance to the family of the Acidaspidæ, which follows next, and I shall reserve the description of both of these groups till all the available material is collected.

CHEIRURUS, *Beyrich*, 1845.

Head strongly trilobed; glabella with three lateral lobes, the basal ones circumscribed; eyes faceted minutely; facial suture ending on the external margin [under side of head with a transverse rostral shield, *Barrande*]. Cheeks generally scrobiculate. Labrum inflated, oblong, truncate, with a pair of furrows and small lateral auricles.³ Thorax of ten, eleven, or twelve joints, variously sculptured in the different subgenera.

¹ Goldfuss's introductory remark to his 'Essay on Trilobites' is still very applicable to the group, if not quite germane to the subject. I beg to refer the curious reader to it ('Neues Jahrb.,' 1843, p. 537).

² There is also a blind Devonian genus of this group, from Africa, in Lower Devonian,—*Typhloniscus*.

³ See Plate VI, figs. 12, 13. We want a term, and I propose the above for these lateral portions of the labrum, very distinct in *Cheirurus*, *Lichas*, &c.

Subgenera.

Crotalocephalus, *Cheirurus*, *Eccoptochile*, *Actinopeltis*; and most probably *Sphærexochus*, ought to be added. It is simply convenient to keep this last as a distinct genus.

Subgenus—CROTALOCEPHALUS, *Salter*, 1853.

Glabella oblong, broadest in front, with furrows continuous across. Body-rings 11, nodular.

Devonian. Upper Silurian.

Subgenus—CHEIRURUS, *Auctorum*.

Glabella broadest in front, with furrows all distinct, but not meeting across. Body-rings 11, nodular.

Upper and Lower Silurian.

Subgenus—ECCOPTOCHILE, *Corda*, 1847.

Glabella ovoid, not much inflated, with long furrows. Body-rings 12, grooved imperfectly, not nodular.

Upper Cambrian? Lower Silurian.

Subgenus—ACTINOPELTIS, *Corda*, 1847.

Glabella ovoid, often much inflated, and with the anterior furrows nearly obsolete. Body-rings 10, grooved imperfectly, subcylindrical, not nodular.

Many of these lead directly to the genus *Sphærexochus*, which has only the characters of *Actinopeltis* in an exaggerated form. Its labrum is like that of *Actinopeltis*, and its pleuræ are subcylindrical, and the body-rings 11.

Subgenus—CROTALOCEPHALUS.

CH. (CROTALOCEPHALUS) ARTICULATUS, *Münst.*? Pl. VI, figs. 7, 8.

CALYMENE ARTICULATA, *Münster*. Beiträge, vol. iii, pl. v, fig. 7, 1840.

— STERNBERGII, *Phillips* (not *Münster* nor *Boeck*). Pal. Foss., fig. 247, 1841.

CALYMENE — *Burmeister*. Organ. Trilob., 2nd ed., p. 116, 1846.

CHEIRURUS ARTICULATUS, *Salter*. Decade Geol. Surv. 7, pl. i, art. 1, p. 10, 1853.

— — *Id.* Morris's Catal., 2nd ed., p. 103, 1854.

C. capite $1\frac{1}{2}$ unciam lato, longo, convexissimo, articulado. *Glabella* subcylindrica, anticè latior, lobo frontali semicirculari, supremo lineari, secundo subtriangulari, basalibus trigonis subplanis longis, ferè medium glabellæ attingentibus, cervicali triangulato lato. *Genæ* declives convexæ, profundè scriptæ et marginatæ, spinis divergentibus brevibus. *Oculi* haud ad glabellam appositi, ad lobum medianum retracti. *Junior cum senioribus formâ convenit.*

When described for the Decades of the Survey, we possessed but one or two imperfect heads. Now we have excellent specimens from Mr. Pengelly's cabinet. These show the true shape of the glabella and the fixed—but not the free—cheeks. Lest there should be a mistake, I have only given the characters from the British specimens, which differ from Münster's figure in having a shorter glabella, with the terminal lobe especially not so long, (Münster's figure has it almost circular, which is not likely), and narrower cheeks; and that author also describes his species as having *great* wings, or free cheeks, like those of his *C. propinqua*. If his figures were quite trustworthy,¹ our species must be distinct, and I should, in that case, propose the term *C. Pengellyi* for this fine Devonian fossil.

Our species has the head eleven lines long, by one and a half inch broad, the glabella occupying the whole length, and regularly tapering from a breadth of eight lines in front to six at the base. The forehead-lobe is semicircular, and occupies just as much length as the remaining lobes, excluding the broad, subtriangular neck-segment. The middle and upper lobes are separated by complete, deep, transverse furrows, and are of equal width, the upper pair forming a transverse linear band, the middle pair also transverse, but rudely triangular where they abut on the truly triangular basal lobes. These reach far across, and are separated by a depressed space barely equal to half the width of one of the lobes. The basal lobes are less tumid than the rest, the upper lobe more so than the middle one, and the forehead-lobe more tumid than any. These proportions are maintained in young specimens (see fig. 8). The surface of the glabella is coarsely tubercular.

The cheeks, separated by deep axial furrows, are convex, rather steeply declining, their full width equal to that of the glabella at its base, and the position of the eye-line is such that the free cheek is not above one third the length of the head (in Münster's figure it is much more), with a strong thickened margin and marginal furrow, within which the cheek is deeply punctured, and appears tubercular; the head-spines diverge, and are short and narrow.

The profile-view (fig. 7, *b*) gives a good idea of the convexity of the head.

¹ Count Münster gives us good reason to distrust his accuracy, for he figures the lower glabella-furrows as continuous across, instead of bending down to join the triangular basal lobes. This is impossible. He has represented his so-called *C. Sternbergii*, and *C. propinqua*, which are probably but one species, as having these broad wings, but there is an appearance of error about all his figures.

The specimens figured are destitute of body and tail; perhaps our Devonian friends can supply better examples.

Locality.—MIDDLE DEVONIAN LIMESTONE of Lammaton, Torquay (Mr. Pengelly's and Mr. Vicary's cabinets, Mus. Pract. Geology).

CHEIRURUS BIMUCRONATUS, *Murch.* Pl. V, figs. 1—5; Pl. VI, figs. 9—18.

PARADOXIDES BIMUCRONATUS, *Murchison*. Sil. System, pl. xiv, figs. 8, 9, 1837.

— — — *Milne-Edwards*. Crust., iii, p. 343, 1840.

CALYMENE SPECIOSA, *Hisinger*. Leth. Suecica, 2nd suppl., t. xxxix, fig. 2, 1840 (not of *Dalman*).

ARGES BIMUCRONATUS, *Goldfuss*. Neues Jahrbuch., p. 544, 1843.

CHEIRURUS — — *Beyrich*. Ueber einige Böhmische Tril., pp. 18, 19, 1845.

— INSIGNIS, *Id.* Ibid., p. 12, fig. I, 1.

— — — *Barrande*. Notice Préliminaire, p. 49, 1846.

— — — *Id.* Syst. Sil. de Bohême, pl. xli, figs. 1—13 (optimè), 1852.

— SPECIOSUS, *Salter*. Memoirs Geol. Surv., vol. ii, pt. 1, pl. vii, figs. 4, 5, 6.

CERAURUS WILLIAMSII, *M'Coy*. Ann. and Mag. Nat. Hist., p. 408, 1849.

— — — *Id.* Pal. Foss. Woodw. Mus., pl. i, f, fig. 13, 1851.

CHEIRURUS BIMUCRONATUS, *Salter*. Decade 7, pl. ii, 1853.

C. (Cheirurus) grandis, 8—10-uncialis. *Glabella supernè latior, sulco frontali et oculari obliquis propè medium glabellæ terminatis; lobis inferis trigonis (ætate rotundioribus) sejunctis. Genæ glabellæ angustiores, oculis medianis, spinis posticis parallelis. Thorax pleuris trituberculatis. Cauda parvula, utrinque pleuris tribus subæqualibus ad basin brevisulcatis, apicibus robustis in ætate arcuatis, sæpe mucrone centrali brevi.*

Few Trilobites are more common than this in the border-counties of England and Wales, and few are so seldom found in a perfect state. We owe the beautiful specimens here figured to the care and diligence of the Dudley collectors, who, following the good example long ago set by Mr. John Gray, are patiently developing the shale specimens which used to be neglected. It is found that the shale matrix preserves the fossils best. Mr. Gray is still at work, and is the master of this art. Our good friend, Mr. C. Ketley, of Smethwick, is hardly less skilful, and we are much indebted to both these gentlemen. Mr. Allport, of Birmingham, Mr. E. Hollier, jun., of Dudley, and others, have lent us choice materials. We now know the whole of this species, which, when first described, was one of the most obscure of all our Trilobites. It has a wide range, from Caradoc to Ludlow Rocks inclusive. It is found in North Europe, but not in America; and it is an excellent type of the genus *Cheirurus*. Neither unduly inflated in the head, nor greatly depressed, as in some of the Lower Silurian species, it is a typical form, with glabella-furrows running partly and not com-

pletely across, and with an oblong shape of glabella, the aberrant species having it oval, and some even globular, as we shall see further on.

It was first described as a *Paradoxides* by Murchison, who only knew the caudal portion; the head was figured about the same time by Hisinger, under the name *C. speciosa* of Dalman, an identification which there is now every reason to doubt, as the synonymy has been cleared up by the labours of Angelin, to whom we should be still more indebted were his descriptions less brief. As I have endeavoured in the Decades of the Survey¹ to show the history of the species, I need not go over all that ground again, and I retain the name *C. bimucronatus*, as already well known and adopted by several authors; indeed, it appears to have been the earliest.

Var. α , BIMUCRONATUS. Pl. VI. figs. 15, 16, 17. *Cauda mucronibus posticis angustis, centrali nullo.* Decade 7; Geol. Survey, pl. ii, figs. 4, 5, 6.

Var. β , CENTRALIS. Pl. VI, figs. 9, 10, 11, 12, 13, 14, 18. *Cauda mucronibus subæqualibus, centrali brevi distincto.* Mem. Geol. Surv., l. c., fig. 7; Decade 7, pl. ii, fig. 16.

The following is the description given in the Decade, with some modifications, and the omission of details.

One of the larger Trilobites; it measures occasionally nine (not twelve) inches, but probably not more. The more perfect specimens found at Dudley are not above two or three inches long, those from Malvern are larger, and those from the Caradoc limestones of South Wales and Ireland the largest of all. Length to breadth as 3 to 2; the head occupies fully one third the length, and is a little broader than the body. General form moderately convex and oblong, but narrowed suddenly towards the posterior end; the sides of the thorax and tail deeply serrated by the projecting ends of the segments. The animal is sometimes found half coiled up; the pointed ends of the pleuræ closing together, and overlapping each other.

Head rather more than a semicircle, the obtuse front projecting; glabella gently convex, equal in breadth at the base to the cheeks, above considerably broader, marked with three strong furrows on each side, besides the neck-furrow, the lowest being directed obliquely downwards, and joining the neck-furrow before reaching the middle; it thus encloses a spherical triangle as a basal lobe. In older specimens this lobe is somewhat squarer, and the furrow more curved. The other furrows curve but little downward, and are variable in length, but usually extend more than one third across the glabella on each side. The furrows on the glabella, as well as the axial furrows, are sharp, but not broad or deep exteriorly, although they are so on casts of the inner surface. Forehead-lobe of

¹ Decade 7, 'Geol. Surv.,' plate ii.

moderate size, half as long as the entire glabella, and on the sides overhanging the other lobes; in front it is somewhat produced, and occupies all the margin. The glabella is neither gibbous nor depressed, a line taken from the front edge to the neck-furrow presenting a regular and gentle convexity. Cheeks subtriangular, not so wide as long, with a broadish margin distinctly separated by a furrow, which meets the strong, straight neck-furrow at the posterior angles; these angles are spinous, the spine short and directed backwards. The eye is placed more than half way up the cheek, and not close to the glabella; it is opposite the middle furrow, and is rather small, supported by a raised rim below; the eyelid is narrow and indented, the lentiferous surface very convex, supine, and covered with minute, closely set, convex facets, with no spaces between them. In some specimens each facet has a minute pit upon it, but this is due to wear; the lenses being regularly convex when perfect. These are figured in the Survey Decades. Above the eye the facial suture takes a vertical course, and cuts the margin exactly where the axial furrow ends on it; below the eye it turns directly outwards to the smooth border, which it cuts considerably in advance of the posterior angle, and in an oblique direction, so that it reaches further back on the lower side than on the upper.

We do not know the course of the suture in front; it is probably direct across, beneath the front margin, and Barrande describes a rostral shield on the under surface. The surface of the glabella is sparsely covered with small granules (fig. 9), the cheeks are largely scrobiculate, and the wings or free cheeks have their border smooth, and only scabrous on its outer edge; they are sometimes dilated a little in advance of the facial suture. Labrum (Pl. VI, figs. 12, 13) large, ovate, oblong, very convex; its length generally one fourth more than the width, but in appearance often more; broadest near the strongly arched base of insertion, from which the central convexity rises immediately, and reaches nearly to the tip. A rather deep furrow surrounds the central portion, and separates it clearly from the more or less tumid margin. The furrow becomes deepest near the rounded shoulder, which we have called the 'auricle,' followed by a deep notch, above which the ascending processes (*a, a*) take their origin. The apex of the labrum is truncate, the corners angular, or even mucronate. Besides the distinct sulcus, which separates the border all round, there is a short oblique furrow higher up on each side. The whole surface of the labrum is closely scabrous (Pl. V, fig. 5); the convex portion has, besides, scattered, larger granules. The organ is hollow when viewed from the inner side (Pl. VI, fig. 13), and the structure there observable is such as has been described by Barrande.¹ There are two ascending pro-

¹ M. Barrande, 'Neues Jahrbuch,' 1847, p. 389, has given a full description of the 'hypostome' of Cheirurus. He describes the ascending processes *a, a* (Flügel), as bent upwards at right angles to the surface of the organ, and uniting with the upper crust along the line of the dorsal or axial furrow, with a broad base of attachment, reaching from the upper to the middle glabella-furrow. In *Phacops* it has nearly the same position. He also describes a second organ, of the same size and shape, but less convex in all its parts, lying immediately behind the hypostome, between it and the upper crust of the head. This organ he calls "epistoma;" and he has seen it both in *Cheir. insignis* and a species of *Phacops*. It has

cesses (*a*, *a*) rising from the ends of the basal or front margin, and directed obliquely backwards; and on the sides (*z*, *z*) are two inflated, broadly triangular portions characteristic of the genus. These triangular curved plates give the appearance of thickness on viewing the organ from the side (fig. 13*c*); but the general surface on the inner side is concave, answering to the great convexity of the outer side.

Thorax much longer than the head, but narrower, and for most part of it parallel-sided, of eleven gently convex rings, which are very minutely scabrous; the axis is narrower than the glabella, of nearly equal width all the way down, but scarcely so wide as the pleuræ. These are linear, and directed straight outwards for two thirds their length, then curved a little backwards, and tapering to a sharp point. The fulcrum, placed at about one third, is of singular structure; a small, semi-oval piece (fig. 14, *a*) is attached to the posterior edge of each pleura; and against this piece abuts a similar tubercle (*b*), placed on the front edge of each; and the two pieces, forming together a narrow oval tubercle, are insulated by a deep sulcus from the body of the pleura, which is also constricted and furrowed across at this point so as to have the outer and pointed portion (*c*) quite distinctly separated from the small inner one. The latter is very strongly divided into two tumid lobes by a short oblique sulcus, and just beyond the constriction the outer portion rises into a stout boss, giving the tri-tuberculate form characteristic of the genus. The line of the fulcral-points is parallel to the axis for its whole length, and the constriction beneath them, though not very marked on the upper crust (fig. 14), produces a longitudinal ridge on the under surface and a corresponding strong furrow in casts (fig. 14*d*).

Tail, in all our specimens, very much narrower than the body, with three strong spinous lateral lobes on each side directed backwards, the outer ones a little divergent and longest; all extend equally backwards; the tail is therefore truncate, but exclusive of the spines, it is broad-triangular, following somewhat the shape of the axis; it is marked on each side by four short, deep puncta or furrows, which do not run to the margin, even in young individuals. The axis is convex and short-conical, of three distinct ribs, and a small terminal piece, the last very obscurely indicated; there is, between the lowest spines in the ordinary Wenlock forms, sometimes a blunt, sometimes an acute mucro, and occasionally none at all.

Variations.—The following have been observed:—In a Dudley specimen the front or forehead-lobe occupies much more than half the length of the glabella, the side lobes being, therefore, more crowded. In another Dudley specimen a large tubercle occurs in the middle of the forehead-lobe. In some individuals the glabella widens more above; in others it is nearly parallel-sided, and the lateral furrows vary in length. The head-spines occasionally reach the third thorax-segment. The margin of the cheek in one specimen is notched at the facial suture. The axis of the thorax is sometimes, though rarely,

never yet occurred to our observation, nor apparently to others. Yet it seems not unlikely that two plates, an upper and under lip, should form the channel to the mouth.

as wide as the pleuræ. The most important variations occur in the tail. In figs. 10, 15, we have represented the spines as all directed backwards, and the two central ones closely approximate; they are so in the large Ledbury specimen figured in the 'Silurian System,' where, too, they are shorter than the outer spines. In others they are a little space apart. In a Lower Silurian specimen we have seen a small tubercle appear between, and in our var. β , figs. 9, 18, a decided, though short, mucro protrudes. Lastly, as a monstrous variety from the Silurian rocks of Kildare (we have reason to think it of the same species), we have one with a wider interval and a bifid mucro. In old specimens, as well as in var. β , the spines diverge much more than in most of those here figured. Perhaps some of these variations are due to sex. It is observable in some specimens (fig. 9) that a double row of tubercles, like those observed in *Phacops* (p. 52), occurs down the axis of the thorax.

Affinities.—Among a host of kindred species in this prolific genus, the only Bohemian fossil with which it is really necessary to compare this is the *C. insignis*, Beyrich. Barrande's figures leave nothing to desire, and I confess I know not how to separate the two. *C. insignis* has a somewhat different habit, and the central tail-spine is more prominently developed. But except this, and having a less overhanging glabella, I do not know how to distinguish the Bohemian form, nor can my friend Mr. H. Woodward see any differences of value.

With the *C. speciosus*, as figured by Hisinger, I believe ours to be identical. *Ch. (Calymene) ornatus* of Dalman has the head very like, as we learn from Angelin's figure; but the upper glabella-lobe of that species is not nearly so long as ours, nor is it wide enough above. The British species is variable enough; but it is, for all that, distinct from those above quoted.

Localities.—CARADOC to LUDLOW ROCKS; CARADOC, South Wales, near Haverfordwest, abundant; North Wales; Kildare, Ireland. LLANDOVERY ROCKS of Goleugoed, near Llandovery, South Wales; Mullock, Ayrshire; Galway, &c. MAY HILL SANDSTONE, Norbury; (Pl. V, fig. 3). Also in the purple Shales, Onny River, Shropshire. WOOLHOPE LIMESTONE, Presteign; Malvern. WENLOCK LIMESTONE and SHALE, everywhere. Wenlock strata of South Wales, and West of Ireland. AYMESTRY LIMESTONE, Downton Castle, Ludlow. Also in Sweden and Bohemia (Upper Silurian).

CH. (ACTINOPELTIS) JUVENIS, *Salter*. Pl. V, figs. 9—12.

CHEIRURUS JUVENIS, *Salter*. Memoirs Geol. Survey, vol. ii, pt. 1, pl. vii, figs. 1—3, (exclude 3, *b*, which belongs to the next species), 1853.

— CLAVIFRONS, *Id.* Ibid., Errata, p. viii.

— — *Id.*, in Appendix Synops. Palæoz. Fossils of Woodw. Mus., t. i F, fig. 11; t. i G, fig. 9, 1851.

CERAURUS CLAVIFRONS, *M'Coy*. Ibid., p. 154 (but not t. i F, fig. 12, for which see *Sphærexochus boops*).

This rather common fossil has been bandied about, in search of a godfather, for some

time, and, having found a resting-place in the verdict of Prof. M'Coy and myself, must be again disturbed; for there seems little doubt that, whatever Dalman's *C. clavifrons* may be, it is not a species with a narrow front to the glabella. Prof. Angelin's figures, quoted under the next species, give us a clue through the uncertainty which has hung over this species; but unfortunately his scanty description does not enable us to clear it up. Prof. Sars and Dr. Boeck described first one and then a different Trilobite under this name; and neither was the true species of Dalman, who, as if to justify all the confusion that has since resulted, placed two distinct species together in the Stockholm Museum under the name *C. clavifrons*, one of which has the glabella narrow in front and parallel-sided, and could not have suggested the term (Angelin, 'Pal. Suec.,' t. xxxviii, fig. 9); to this one Prof. Angelin has, however, applied the name; the other, with a subclavate glabella and minute eyes (pl. xxxviii, fig. 10, which does deserve the name *C. clavifrons*, and to which Prof. Angelin attaches that synonym and the note as to Dalman's authority), he by some strange fatality calls a new species, *Cyrtometopus affinis*!

We shall never have done with the confusion of these forms, unless we restrict Dalman's name to the species called *C. affinis* by Angelin. In that case I believe our next species will have to forego its baptismal privileges. But pending the settlement of this (and the difficulty is increased tenfold in a genus like *Cheirurus*, full of closely related and very similar forms), I shall revert to my old name, *Ch. juvenis*, which sufficiently expresses the smooth contour of the head. It is certainly distinct from all the Swedish forms, though resembling all which have figured under the above name; and the synonyms given above may, I think, be trusted; all the specimens have been seen by myself.

C. juvenis is a large trilobite for this section of the genus, and must have measured three inches in length. It has not yet occurred perfect; but the glabella is rather common, both in Wales and Ireland. It is an ovate and very convex mass, equally attenuate at each end, gibbous along the median line, and regularly convex along a line taken from front to back, not projecting near the base, and scarcely overhanging the front. The furrows are three on each side, the basal one strong, and completely circumscribing the oval basal lobe; the middle and upper ones gently curved, and equally remote from each other and the basal lobe. The front furrows are placed very forward.

The cheeks are steeply curved down, but not abruptly so; the neck-furrow strong, the surface scrobiculate, the eye placed behind the middle furrow, and therefore about half way up the cheek. We have not the free cheeks, but they probably showed a narrower margin than in the following species. The glabella is covered equally with granules and tubercles. Head-spines short.

Tail with very unequal lobes, the outer ones by far the largest, and produced into stout, slightly divergent spines, with a broad subquadrate base, marked by a short, deep, pleural groove. The two inner pairs are rapidly smaller, the last quite minute. But these vary in length and obtuseness. In our figured specimen they are not longer than the broad, long, conical axis of four joints, which intrudes its last joint between the short terminal

mucrones, and which is, at its upper portion, as broad as its pleuræ, which have a wide, straight base of articulation. The articular portion of the axis is also large.

Fig. 9 represents the outer granulated surface of the glabella. The furrows are not so deep as in the cast (fig. 10); but the cheeks are equally scrobiculate, and more strongly so than in our next species.

Comparing with other species, we find, first, that the original *C. clavifrons* of Dalman is, according to Angelin's figure, a species with a narrow glabella, somewhat gibbous at the base, and with very broad and deep-fixed cheeks, with strong head-spines. The basal lobes of the glabella are prominent and circular. The *C. affinis* of Angelin, which was placed by Dalman with this, and seems by its shape to have been the actual species intended by him, has a subclavate glabella, and also very forward, minute eyes. The glabella of *C. tumidus*, Ang., a good deal resembles the large corresponding part in our species; but it differs essentially in not having the basal furrows complete, and the base is very broad. *C. gibbus*, Ang., does not need a very close comparison, while the several species arranged under *Sphærexochus* by Angelin must wait for more perfect materials to decide their collocation.

Localities.—CARADOC SLATES and LIMESTONES of Wales, Westmoreland, and Ireland. In North Wales,—west of Bala Lake, Rhiwlas, &c.; Corwen; Cerrig-y-Druidion, &c.; Llanfyllin and other places in Montgomeryshire. In South Wales,—Sholes Hook, Haverfordwest; abundant. Coniston, Westmoreland (M'Coy); Wexford and Chair of Kildare (Mus. P. Geology, Woodw. Mus., &c.).

CH. (ACTINOPELTIS) OCTOLOBATUS, *M'Coy*. Pl. V, figs. 13, 14.

? CALYMENE CLAVIFRONS, *Dalm.* Vetensk. Akad. Handl., p. 75, 1826.

? — — — *Lovén.* Ib., p. 63, 1845.

SPHÆREXOCHUS CLAVIFRONS, *Salter.* Memoirs Geol. Survey, vol. ii, pt. 1, pl. 7, fig. 3, 1849.

CERAURUS OCTOLOBATUS, *M'Coy.* Synopsis Foss. Woodw. Mus., pl. 1G, fig. 10, 1851.

CHEIRURUS — — *Salter.* Decades Geol. Surv. 7, art. 2, p. 11, 1853.

CYRTOMETOPUS AFFINIS, *Angelin.* Palæont. Suecica, t. xxxix, fig. 10 (1855, not 1854),
(and quoting *C. clavifrons* of Dalman from the
originals in the Swedish Museum!)

Ch. (Actinopeltis) minor, ovatus; capite gibbo; glabellâ oblongâ nec ovatâ; genis declivibus; caudâ 8-lobatâ, brevi. Glabella convexissima tuberculata granulosa, anticè paullulum dilatata, posticè sulcis completis lobos rotundos circumdantibus; sulcis anticis longis. Genæ declives, externæ parvulæ, ferè perpendiculares, scrobiculatæ; oculis minutis. Pleuræ spinosæ. Cauda transversa bis quam longâ latior, subplana, axe haud

eminente; pleuris utrinque 4 æqualibus ovatis planis, apicibus omnibus ovatis retrorsis, nec radiatis.

A pretty species, which I was glad to recognize as an old friend, when Mr. Henry Woodward called my attention to it in the British Museum. *Ch. octolobatus* had long been described from the tail only; but it was not suspected that it belonged to the section *Actinopeltis*, and was so nearly allied to the *Ch. clavifrons* as to make its separation a matter of critical distinction. If it be the *Cyrt. affinis* of Angelin (he has only figured the head in a side-view, and described it as smooth), our British name must give way to the prior one, for it seems to be really the long-contested *C. clavifrons* of Dalman.

It is a small species, the three caudal shields known not indicating a fossil much larger than one and a half inch long, of which the gibbous head occupies rather more than a third, and is a little broader than the body, with steep, almost vertical cheeks, which, measured in their own full width, are equally wide with the glabella, but do not appear so in a front-view. The glabella is oval-oblong, blunt in front, and rather broadest there, where it overhangs a narrow, very distinct margin. A line taken from front to back is regularly convex, and the glabella is much elevated, both above the front margin and the narrow neck-segment. The glabella-furrows are a basal pair, which completely surround the rotund-oval basal lobes, only somewhat fainter where they join the neck-furrow; and two upper pairs, rather long, placed at equal distances, the middle furrow being about the length of the basal lobe apart from it, and as remote from the front one. The front furrow comes thus very forward, and on a line with the deep marginal furrow of the cheek, opposite the notch between the facial suture and this margin. The cheek is rudely triangular, strongly margined all round (spinose, probably, at the head-angles), and with the very small eye placed on the side of the declivity, and a good way in advance of the middle of the cheek, opposite the ocular furrow. The free cheek is small and triangular, bisected by the deep marginal furrow. The cheeks are scrobiculate all over, the glabella covered with fine granules, and scattered larger tubercles, very equally.

Body-segments eleven, with a broad axis, equal to the pleuræ, and only abruptly tapering in the two or three last segments. The pleuræ semicylindrical, the posterior portion being so broad and convex as to occupy nearly the whole width of each,¹ the fulcrum placed rather far out, and the pleuræ then bent downward and a little backward, faceted distinctly, and ending in a point. The hinder ones are most bent back, and follow the curve of the tail-border.

Tail transverse-oblong, nearly rectangular, the segments ending regularly behind, along a nearly straight line. There are four on each side, the front ones bent at right angles, and all nearly equal, with bluntish ovate tips. No space between the two terminal ones. The axis short, of two segments and a very small terminal portion.

¹ There is no central line in this, to indicate a pleural groove, as in *Eccoptochile* (and some species of *Actinopeltis*). It would appear that this character is not even of subgeneric value in some cases.

Comparing the side-view fig. 13, *a*, with the side-view fig. 11 of the nearly allied species, *C. juvenis*, we at once see that it is distinct, and at the same time how very closely these species of *Actinopeltis* approach each other. The glabella of *C. juvenis* is oval, not oblong, and the free cheek less triangular, and a good deal larger, judging from the much smaller fixed cheek left behind. The eyes, too, are placed far more backward, and the neck-segment is more prominent. And if I am right, as I believe, in referring the tail (fig. 12) to that species, there is, of course, no need to compare them minutely.

Cyrt. affinis of Angelin is very like ours; I think it can only be a synonym.

Localities.—Greenish CARADOC Sandstone of Pinwhapple, Ayrshire (Brit. Mus.); Rhiwlas, Bala, and Cerrig-y-Druidion, Denbighshire (Mus. P. Geology).

CH. (CHEIRURUS) GELASINOSUS, *Portlock*. Pl. V, figs. 6—8.

AMPHION GELASINOSUS, *Portlock*. Geol. Rep., t. iii, fig. 4, 1843.

ARGES PLANOSPINOSUS, *Id.* Ibid., t. v, fig. 9.

CHEIRURUS GELASINOSUS, *Beyrich*. Böhm. Tril., i, p. 19, 1845.

— PLANISPINOSUS, *Bronn*. Ind. Pal., 1848.

— GELASINOSUS, *Salter*. Quart. Geol. Journal, vol. vii, pl. viii, fig. 1, 1851.
Decade 7 Geol. Survey, art. 2, p. 11, 1853. Siluria, 2nd ed., p. 538, 1859.

Ch. (Cheirurus) depressus, 3-uncialis. Caput transversum, glabellâ rectangulari, sulcis brevibus transversis, lobo frontali brevi, basalibus oblongis transversis vix circumscriptis, uno ab altero spatio æquali sejunctis; genis latis, marginibus aepressis, spinis brevibus. Cauda (hic haud dubiè referta) lata, segmentis utrinque tribus latis, ad basin longe adnatis, acuminatis; primo in appendicem longam producto, secundum longè excedente, hoc tertium brevem superante; axe 4-annulato, articulo ultimo minimo angusto, nec apicem caudæ profundè emarginatum attingente.

The specimens figured by General Portlock¹ no doubt belong to one and the same species; and the form has been recognized by both Beyrich, Barrande, and myself, as a *Cheirurus*. It is rather a remarkable one, for the extreme width and shortness of the head; but the tail is of the ordinary form for the genus.

We have specimens of the head nearly two inches wide; the whole length may have been three and a half inches, of which the short, wide head measures only ten lines. The glabella is not so wide as the cheeks, and is rectangular-oblong, with the upper angles slightly rounded, and the sides strictly parallel. The furrows equal in length, rather long, oblique, and but little curved downward, the basal ones complete, and enclosing triangular oblong lobes, separated from each other by a space equal to their own diameter.

¹ While these pages are printing, we have to record the loss, at an advanced age, of this distinguished man. His work in various departments will endure long, for it was done well.

The neck-furrow strong. The forehead-lobe is small, generally equal in breadth to the rest, but no wider; the other lobes equal in length and width. The axial furrows are deep and strong; in them, opposite the front furrows, are deep pits on each side in the cast, which indicate the place for the processes, which join the corresponding projections of the labrum. The cheeks are convex, wide-triangular, with a broad margin, and a narrow, deep neck-furrow, continuous, as in all the genus, with the outer marginal furrows. The free cheek is small; the eye small, and placed midway on the most convex part of the cheek; the facial suture curving strongly inwards above the eye, and outwards and upwards behind it. Spines short? and rather thick, directed backward. The whole cheek is closely pitted, and the glabella and neck-segment sparsely covered with coarse tubercles.

The tail (*Arges planispinosus*, Portl.) is very flat, and moderately transverse, with a broad triangular axis of three rings, and a minute terminal appendix, which does not quite reach the notched apex. The upper side-lobes or pleuræ are largest and longest, broad-lanceolate, with a short pleural groove, and directed outwards; the second pair ovato-lanceolate, and diverging but little; the terminal pair of the same shape, but parallel, and with a deep notch between them. All the lobes are adnate, but strongly separated by furrows, and extend backward to about the same distance. Surface unknown.

Localities.—CARADOC. Tyrone (figs. 7, 8); Ayrshire (fig. 6), in the Craig Head Limestone (Mr. J. C. Moore), occurring with *Heliolites*, *Petraia*, and *Pleurorhynchus*. (All three figured specimens are in the Mus. Pract. Geology.)

CH. (CHEIRURUS) CANCRURUS, *Salter*. Pl. V, fig. 15 (and 16?).

CHEIRURUS GELASINOSUS, *M'Coy*. Synops. Sil. Foss. Ireland, p. 44 (not of *Portlock*). 1846.

— CANCRURUS, *Salter*. Decade Geol. Surv., No. 7, Art. 2, p. 11, 1853.

— — *Id.* Siluria, 2nd ed., p. 538, 1859.

Ch. (*Cheirurus*) *satis magnus, caudá lineas 20 latá, transversá, apice abruptè truncato præmorso; axe lato, annulis quatuor subæqualibus, tertio à quarto punctis binis remotis solum separato; lateribus spinis quatuor longis sub-parallelis, ad basin adnatis, transversis, apicibus lente decurvatis; basalibus utriusque lateris longo intervallo remotis.*

A most remarkable species, in which the four lateral lobes of the tail start horizontally from the broad axis, instead of gradually converging beneath it, and leave its apex bare; the breadth of this space being increased by the outward direction of the spines themselves, which begin to curve downwards only when they have attained half their length. The appearance of the perfect tail is just like that of a crab; *præmorsus* might have been an appropriate specific name. *C. obtusatus*, a Bohemian species, somewhat resembles this; but the spines are radiating, not parallel. None of *Angelin's Lower Silurian Swedish*

species are very like this; *C. clavifrons*, Dalm., and *C. Sarsii*, Angelin, have some relation to it; but the *C. conformis*, from the Wenlock of Gottland, is apparently a near ally, and but for the swelled terminal lobe and wider cheeks, might have been identified with ours (see his pl. xxi, fig. 3.)

The species is named from the tail only. It is an inch and three quarters broad, and quite transverse, consisting of both axis and pleuræ of four segments, which are less connected together than usual, even in this genus; and the pleuræ are less metamorphosed than in any that I know. The axis is very broad, and regularly conical; broadly truncate, reaching to the end of the tail. There are four side-lobes or pleuræ, the first two of which are equal in length, and the others but little shorter. All are directed straight outwards for a third of the length, and then curve gently backward, leaving the whole truncate blunt tip of the axis exposed.

C. cancrurus? Head, fig. 16.

The head, which is here provisionally associated with the species, may belong to quite a different one; for it is much elongated, the length equal to two thirds the breadth. The glabella, including the very prominent neck-segment, is not far short of being twice as long as broad. The basal lobes complete and spherical-triangular, the upper furrows short and somewhat curved. The forehead-lobe is as long as all the rest, exclusive of the neck-lobe. The surface finely granular. The eye placed far back. The fixed cheeks narrow and scrobiculate. The margin strongly marked, but narrow. Spines?

Locality. CARADOC LIMESTONE of Chair of Kildare, Ireland (Mus. Pract. Geol. The head in the cabinet of Sir R. Griffith, Dublin).

Section.—ECCOPTOCHILE. See p. 61.

CH. (ECCOPTOCHILE) SEDGWICKI. Pl. V, fig. 17.

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| CRYPTHÆUS SEDGWICKI, | <i>M'Coy.</i> | Ann. Nat. Hist., 2d ser., vol. iv, p. 406, 1849. |
| ECCOPTOCHILE | — | <i>Id.</i> Synops. Pal. Foss. Woodw. Mus., p. 155, pl. i, r, fig. 14, 1851. |
| CHEIRURUS? | — | <i>Salter.</i> Morris's Catal., 2nd ed., p. 107, 1854. |
| — | — | <i>Id.</i> Siluria, 2nd ed., p. 538, 1859. |

Ch. (Eccoptoch.) triuncialis, rectangularis, subplanus, axe angusto, caudâ latissimâ. Caput (imperfectum) semicirculare?, glabellâ genis angustiore, subclavatâ, sulcis decurvis, basalibus ferè completis; oculis anticis, genis latis profundè scriptis. Thorax segmentis 12,

axe convexo, angusto, latitudine pleuræ dimidium haud efficiente; pleuris latis planis punctato-sulcatis, apicibus acutis lentè decurvis, secundo et tertio sese conniventibus. Cauda lata, axe brevi turbinato 4-annulato, annulo terminali trigono apicem emarginatum attingente; pleuris 6, primum rectis (duobus primis semisulcatis) dein arcuatis, apicibus retrorsis foliaceis ovatis subæqualibus.

I cannot do better than extract Prof. M'Coy's excellent description from the work above quoted, and I think he is fully justified in placing this Lower Silurian form in the subgenus *Eccoptochile*. It is, indeed, a near ally of *Cheirurus claviger*, Beyrich, from which, however, its rectangular, not ovate, shape, and broad transverse flattened tail easily distinguish it.

"Cephalic shield nearly semicircular; glabella slightly clavate, smooth, with three segmental furrows on each side; the posterior pair longest, turning backwards and inwards nearly to the neck-furrow, enclosing a triangular space on each side longer than wide, the width rather less than that of the undivided portion of the glabella beneath their bases, the two anterior pair of furrows shorter; cheeks broad, gently convex, closely and coarsely pitted; neck-segment thick, smooth; eye-line extending with a slight curve to the margin in front of the angles; axial lobe very convex, narrow, slightly tapering, nearly parallel-sided, smooth, of twelve segments; three similar rings belong to the pygidium, a fourth terminal one being obtusely trigonal; the side-lobes are flattened, and more than double the width of the axial lobe; pleuræ nearly straight, narrow, and, for the greater part of their length, flattened, and having a broad, nearly mesial, pleural sulcus, deeply punctured like the cheeks, dividing each into two parts; the posterior largest, and forming a thick, smooth rounded ridge in the distal third of its length, bent down and a little backwards, swelling to a thick, narrow ridge in the middle, the sides and the extremity expanding into a broad, thin, foliaceous appendage; the pygidium terminates in six broad, ovate, leaf-like, semi-membranous flaps. Length of thorax and pygidium two inches two lines, width two inches three lines; width of axial lobe six lines.

"This magnificent Trilobite can only be confounded with the *Eccoptochile clavigera*, Beyrich, from which it is distinguished by the much greater width of the lateral lobes of the thorax, and the thin, flat, leaf-like appendages of the pygidium, which in that species resemble thick, pear-shaped clubs."

Locality. LLANDEILO FLAGS, two miles north of Builth, Radnorshire (Woodwardian Mus.). Also Abereddy Bay, Cardiganshire (Mr. H. Hicks).

CH. (ECCOPTOCHILE) FREDERICI, *n. sp.* Pl. V, figs. 18—21.

CHEIRURUS FREDERICI, *Salter*, in *Mem. Geol. Surv.*, vol. 5, (ined.), pl. viii, fig. 1—3.

Ch. (Eccoptochile) triuncialis et ultra, capite transverso, longispinoso. Glabella oblonga parallela seu anticè angustior, granulosa, sulcis distinctis abbreviatis obliquis quasi

radiatis, lobo antico parvo trigono. Genæ scrobiculatæ nec scriptæ, longispinosæ. Oculi omnino antichi, parvi. Thorax axe modico, ferè ut pleuras lato, his convexis rectis, profundè sulcatis, apicibus recurvis 4, longispinosus. Cauda major, axe 4-(vel.- 7 ?)annulato, longo, limbo sulcato et in spinas 6 retrorsum flexas subparallelas productis.

This Trilobite, found about five years since by Messrs. Homfray and Ash, in the slates of Portmadoc, is a member of a group more characteristic of higher beds. There cannot be much doubt of the genus, and though the long spinous hinder pleuræ are a new character for this section of *Cheirurus*, it can only be compared with such species as the *Ch. (Eccopt.) claviger*, before mentioned, and the *E. Sedgwicki*. From both, the spines—and the deeply grooved, not punctate, pleuræ—distinguish it easily; I am not quite sure if fig. 21 belongs to this or to a distinct species; it is much larger, and has more joints in the tail.

Occasionally as much as three and a half inches long, and rather wide (all our specimens are much compressed). The head is wide, less than semicircular; the outer cheeks, occupying the greater part of the head, are margined all round by a continuous furrow, and produced into long head-spines; the border smooth. The eye is very far forward, as in *E. Sedgwicki*, and the facial suture so forward as to cut the outer margin much in advance of the middle of the head, separating a very small free cheek.

The glabella is not nearly so wide as the cheeks; it is parallel-sided, apparently not much longer than broad, and has the furrows very distinctly marked. These are three on each side, and rather deep, all straight and inclined a little upwards, the front ones especially, so as to have a radiate appearance. They reach more than one third across the glabella, and thus leave but a narrow space down the centre. The front lobe, marked out by the two converging front furrows, is a wide triangle, and does not occupy more than a third of the length of the glabella, the surface of which is granulated.

Thorax apparently of only eleven flattened rings, of which the axis is not quite so wide as the pleuræ; these last are convex and deeply grooved along the middle, almost to the ends; each is produced into a long, sharp spine, bent backward in all the segments; but in the four or five hinder ones the spines are fully equal to the length of the pleuræ themselves.

The tail, which can hardly be distinguished from the thorax, has in the more perfect specimen (fig. 18), only four joints and a terminal piece to the axis. In fig. 21 there are six or seven rings. The smaller specimen has the tail-spines more lateral. In the larger one they reach more toward the end of the tail; but part of this difference may be due to pressure.

C. Eryx, a species described by Mr. Billings from the Quebec limestones,* has a larger number of tail-spines; but it is a closely allied form.

Locality. UPPER TREMADOC SLATES; Garth Hill, and Penclogwyn, Portmadoc (D.

* In the 'Canadian Naturalist and Geologist,' vol. v, p. 322.

Homfray, Esq.). Mr. Frederic Ash, formerly of Portmadoc, contributed many specimens of Tremadoc fossils to the Museum of Pract. Geology; and the species is named after him, to record his labours in the district.

SPHÆREXOCHUS, Beyrich.

Eyes faceted minutely; head very convex, almost globular; the cheeks not scrobiculate; facial suture ending on the external margin, near the angles, in front continuous and submarginal; glabella large and nearly spherical, with three furrows on each side, the two upper very obscure, the lower strong and curved down to the neck-furrow; thorax of eleven joints, without any furrows; tail of three segments, free at their ends; labrum subtrigonal, with a marginal furrow, but without lateral furrows. No rostral shield.

As the labrum of the last described section of Cheirurus, viz., *Actinopeltis*, has a very similar labrum, it might be difficult to say in what, except in proportion, and in the extreme convexity of all the parts, this very abnormal Trilobite differs from that subgenus. However, as *Sphærexochus* is widely recognised, and as, moreover, there appears to be no rostral shield (that of Cheirurus is well established by Barrande), it is convenient to adopt the name.

SPHÆREXOCHUS MIRUS, Beyrich. Pl. VII, figs. 1—6.

CALYMENE CLAVIFRONS,	<i>Hisinger.</i>	Leth. Suec., 2nd Supp., t. xxxvii, fig. 1, 1840.
SPHÆREXOCHUS MIRUS,	<i>Beyrich.</i>	Ueber einige Böhm. Tril., p. 21, 1845.
—	<i>Id.</i>	— Zweite Stück, t. i, fig. 8, 1846.
—	CALVUS, <i>M'Coy.</i>	Syn. Sil. Foss. Ireland, pl. 4, fig. 10, 1846.
—	MIRUS, <i>Corda.</i>	Prodom. einer Monog. Böhm. Tril., fig. 72, 1847.
—	— <i>Barrande.</i>	Syst. Sil. de Bohême, vol. i, pl. xlii, figs. 11, 18, 1853.
—	— <i>Salter.</i>	Decades Geol. Surv. No. 7, pl. iii, 1853.
—	<i>Id.</i>	Morris's Catal. 2nd ed., p. 115, 1854.

A few years ago this was one of our rare British Trilobites. Now, the accident of a tunnel being driven through the rich formations of the Malvern Hills has rendered it one of the most frequent ornaments of the cabinet. Messrs. Gray and Fletcher obtained the species first from the Dudley Limestone. Sir R. Griffith found it in the Caradoc Limestone of Kildare, and Prof. M'Coy published it almost immediately after Beyrich's description had appeared in 1846. The Geological Survey collected it in abundance from the same locality in Ireland; and now our friends, Dr. Grindrod, of Malvern; Messrs. Hollier and Ketley, of Dudley; and Messrs. Allport, of Birmingham, have contributed excellent materials, which enable us to complete the account.

Larger specimens have lately occurred ; and the finest I know, in Dr. Grindrod's collection, is nearly two inches long. Of this the head occupies more than a third of the whole length, and the glabella is very large, occupying, as seen from above, four fifths of the width, and quite overhanging the narrow front margin. It is, excluding the neck-segment, nearly a true hemisphere, and has a pair of large orbicular lobes at the base, deeply circumscribed, and further apart from each other than their own diameter. The furrow that bounds each of these lobes is broad, sharp, and equal in depth all round, leaving no communication with the body of the glabella (figs. 4, 5, 6). Above these lobes, on each side, are two faint impressed lines, which represent the upper furrows (see fig. 5, *a*) ; of these the one next to the round basal lobe is placed at a less distance from it than the diameter of that lobe, at about the point of the head's greatest width, and the upper one at an equal distance in advance of it towards the front. The cheeks are small in comparison with the glabella, and hang vertically from its sides (fig. 5, *cc*), like a pair of lappets from a cap or helmet ; they are oblong, and have a thickened margin. The small convex eye is placed very near the glabella, and below the middle of the head ; the facial suture runs outwards from it, and reaches the exterior margin, which it cuts obliquely, a little in front of the posterior angle, as is fig. 6 ; in front of the eye it continues parallel to the glabella, and runs along the edge of the narrow front margin, leaving the free cheeks connected beneath by a narrow band (fig. 5, *b*). The free cheek is hatchet-shaped ; and the small eye (fig. 5, *c*) occupies the inner corner, supported on a fold of the crust, which truncates, or even indents it below. The eye is thus pushed up into a supine position ; it is short, oblong, and very convex. The lenses are numerous, larger in size than the granulations of the general surface, and placed near together, less than half their diameter apart. In this specimen we have not the outer surface sufficiently perfect to enable us to say whether the cornea is raised into facets (as Barrande thinks) or not ; from the inferior surface (fig. 5, *d*) the lenses have fallen out, leaving pits which indicate their size. The posterior corners of the head are rounded off, and they bear, instead of a spine, only a small tubercle (fig. 6), which is placed far inwards.

The labrum has not yet been found in England, but it is figured in M. de Barrande's plates, and we reproduce it from a Bohemian specimen (fig. 5, *e*). It is trapezoidal or inverted-pyramidal, half an inch wide by four lines long, straight at the base, where it is much broader than it is long, and the apex is truncate and slightly emarginate. A broad, shallow furrow runs round the end and sides, leaving only a small central convexity of the same shape as the labrum. This convexity is not indented by any lateral furrows. The auricles (see p. 60) are brought to a level with the base, and thus no notch is left between them and the ascending processes, as in those of forms of *Cheirurus* which most resemble it (see Barrande's plates, xl, fig. 30, and xlii, fig. 19).

The surface of the head is covered by a fine, close granulation (fig. 6), which occupies also the free cheeks or wings ; it is, therefore, one of the subgeneric distinctions from *Cheirurus*, in which the cheeks are always pitted or scrobiculate.

Thorax parallel-sided, scarcely tapering backwards, of eleven thick rounded rings; the axis as wide as the sides, and of equal breadth throughout, very convex; each joint much raised and rounded (see fig. 4). Pleuræ horizontal as far as the fulcrum (fig. 6, *d*), and then abruptly deflexed, and from this point the pleura tapers outwards to a conical blunt point, which, at the extreme tip, is a little bent forwards. The fulcrum is placed at rather less than half way from the axis; but in the last segment it approaches much nearer, —to about one third (fig. 6, *f*). Its place is indicated by a protuberance, both on the forward and hinder edge of each segment (fig. 6, *d* and *f*); but these swellings are not isolated tubercles, as in *Cheirurus*, nor are there any oblique or longitudinal furrows on the pleuræ, as in that genus, to break up the uniform convex surface of the segment.

Tail about semicircular, truncate; the axis conical, its base of two depressed close-set rings, its apex of one long triangular joint, which is separated from the second joint by a deep depression; from thence it is flattened, or even depressed, for some distance, but suddenly rises to an obtuse and elevated tip (fig. 6, *g*). When seen endwise the tail presents a bent appearance. The sides are composed of three obtuse convex lobes, which scarcely project on the margin; the upper one follows the bend of the hindmost pleura, the second is less curved, the third parallel to the axis; all are deflected, so that an end-view of the tail gives an angular outline, very distinctly seen in the Decade figure above quoted.

The entire surface of the thorax (fig. 10) and tail, like that of the head, is covered with a fine granulation, the grains of equal size throughout.

Variations.—Our Dudley specimens have the tail somewhat shorter and wider, and the terminal joint of the axis therefore shorter, than those from Bohemia. Irish specimens (figs. 14, 15) are more like the foreign ones in this respect. The space between the lower glabella-lobes is least in these Irish specimens, though some of them have it considerably wider than the diameter of the lobes; in a Wexford specimen the space is proportionally as wide as in those from Dudley, which often have the lobes as far apart as in Bohemian examples.

The species we have to compare this with are many. These are:—the *S. scabridus* of Angelin, which differs but little, and may be identical; the *S. angustifrons*, id., which has flat, expanded lobes to the tail; *S. deflexus*, *S. granulatus*, *S. conformis*, and *S. Wegelini*, of the same author, have incomplete basal lobes; one figured, but not named, by Dr. Beyrich in his second paper (1846), which has the lobes of the tail lengthened out, and the terminal joint of the axis short.* An eighth is that figured in the lower part of our plate (figs. 27, 28), possibly a *Cheirurus* of the *Actinopeltis* group; but having such marked basal lobes, I regard it as a *Sphærexochus* for the present. The last I shall notice is from the Lower Silurian Rocks of Thibet, and has been figured from Col. Strachey's

* This ought to receive a name. The genus is too scanty to render it inconvenient. *S. Beyrichii* would do very well for it.

work.* The projecting bullate lobes of the glabella, in the Indian fossil, give the aspect of staring eyes, and suggested the term *S. idiotes*. Most of the above-mentioned are apparently, but rare species. The really cosmopolitan fossil is the *S. mirus*, which has been found in Bohemia, Sweden, Britain, and North America.

Localities. — CARADOC ROCKS; Chair of Kildare, Co. Kildare; Carrickadaggan, Co. Wexford; Biggar, Lanarkshire (specimens all in Mus. P. Geology): WOOLHOPE LIMESTONE; Malvern? WENLOCK LIMESTONE and SHALE; Dudley, Walsall, Malvern, abundant.

Abroad it is found in Lower Silurian strata of Dalecarlia (Hisinger), Upper Silurian of Bohemia (Barrande), and in Ohio, North America. From the latter locality I have seen specimens in Sir C. Lyell's collection, and M. de Verneuil also quotes it from thence.

SPHÆREXOCHUS? BOOPS, *n. sp.* Pl. VI, figs. 27, 28.

CHEIRURUS CLAVIFRONS, *M'Coy*. Synopsis Pal. Foss. Woodw. Mus., pl. i, f, fig. 12, 1851 (not the other figures, nor of *Dalman*, nor *Angelin*, nor *Sars* and *Boeck*).

I must give this a name, both because of the paucity of British forms of this genus, and to call further attention to it. I had long named it as a distinct species in the Jermyn Street Museum; and lately I have found, by the correspondence (and a careful drawing) of the talented Mr. Harry Seeley, of Cambridge, that M'Coy's figure quoted above represents a more complete specimen than the one in Jermyn Street (fig. 27). M'Coy's specimen is correctly represented in fig. 28. There is some doubt of the genus, for it may belong to the section *Actinopeltis* of the group *Cheirurus*, but the general character is much that of *Sphærexochus*, and we do not yet know the limits of these two subgenera, for such they assuredly are.

I shall content myself with an English description, and only point out its characteristics. It is a larger form than *S. mirus*. The glabella is of an oblong-ovoid shape, very convex, almost gibbous, but not so greatly so as is that of the *Cyrtometopus gibbus*, *Angelin*, a very near ally.

The basal lobes occupy nearly one half of the length of the glabella; they are wider than long, and somewhat oblique,—their shape compressed-sphæroidal, not truly round, and on the inner side they are connected with the body of the glabella by a depressed neck, about half as wide as the width of the lobe itself. The pair of lobes stand apart about as far as their shorter diameter. The neck-furrow is strong, and much arched forwards,

* The work is yet unpublished. But the plates and descriptions have long been printed. The Trilobites (nine species) are figured in Plate I. Among them is a new type allied to *Cheirurus*, but without eye or facial suture (*Prosopiscus*, *Salter*).

and is very prominent and elevated, but not broad ; neither of our specimens show its full width.

The strong convexity of the great eye-like lobes suggests some such name as the above.

Locality.—CARADOC SLATES of Sholes Hook, Haverfordwest (fig. 27, Mus. P. Geology), Applethwaite Common, Westmoreland (fig. 28, Woodwardian Mus.).

AMPHION, *Pander*, 1830.*

Head short, transverse, without spinose angles. Glabella nearly rectangular, with three pairs of furrows, the front pair generally approximate on the anterior margin, and always enclosing a very small forehead-lobe, often narrower than the glabella. Eyes small [reticulate, *Angelin*]; facial suture behind the eyes ending on the exterior margin a little in advance of the rounded angles; labrum entire, pointed, convex, margined all round; body with fifteen to eighteen rings, the pleuræ without grooves; tail of few segments, the axis short, the pleuræ with free terminations [includes *Pliomera* of *Angelin*, 1852].

Amphion is just one of those genera which show the near connection between the *Cheiruridæ* and *Calymene*, to which it is allied by the elongate form, numerous body-segments, glabella not widened in front, and facial suture ending nearly in the angles. On the other hand, it is like *Zethus* and *Cybele* by the grooveless pleuræ and free segments of the tail, which extend beyond the margin as in those genera, and close behind the shortened tail-axis; also by the entire labrum.

From both groups the peculiar shape of the glabella and the numerous unfurrowed pleuræ distinguish it. The typical species is the *Asaphus Fischeri* of Eichwald, which was called *Calymene polytoma* by Dalman. Pander established the genus *Amphion*, but again altered the specific name. In *A. Fischeri* there are eighteen body-rings.

AMPHION PSEUDO-ARTICULATUS, *Portlock*. Pl. VI, figs. 29, 30.

AMPHION PSEUDO-ARTICULATUS, *Portlock*. Geol. Rep. Londond. Tyrone, pl. iii, fig. 5, 1840.

— — — *Salter*, in *Morris's Catal.*, 2nd edit. p. 99, 1854.
— — — *Id.* Siluria, 2nd ed., p. 537, 1859.

A. triuncialis, longus, axe glabellâque convexis, fronte haud contracto. Caput semicirculare, margine angusto. Glabella subparallela, convexa, lobis brevibus, subradiatis, antico quam glabellâ lato, transverso, lineari. Oculi retrorsi, prope glabellam positi. Thorax segmentis 17, axe convexo. Cauda expansa, pleuris subclavatis 5, duobus terminalibus post axin abbreviatum subplanum omnino connatis.

* 'Beiträge zur Geognos. des Russich. Reiches,' Petersburg, 4to.

It was a proof of the late General Portlock's scientific acumen to have decided this to be an *Amphion*, a genus, be it remembered, never recognised in Britain before his work appeared; for assuredly the characters of the head are unlike those of the typical species, and yet there is no manner of doubt we must admit it, and enlarge the generic character so to do. The forehead-lobe is much wider in this than in the other species, as our woodcut will show. (Fig. 17.)

The species probably grew three inches long, as indicated by fig. 30. The head is transverse, semicircular, or nearly so; the glabella, which is moderately convex, occupying fully one third, and regularly, but very slightly, tapering backwards to the small neck-segment. The furrows are three on each side, very short, and somewhat radiating, enclosing a linear basal lobe, a clavate middle one opposite the eye, and a subrectangular upper lobe, between which and the very short, wide, and transverse forehead-lobe is only a short, straight furrow; but beneath this it is continued as a faint curved depression (not shown in our figure), so as to follow the direction of the middle or ocular furrow. The forehead-lobe (and this is unusual for the genus) is as wide as the rest, and is a narrow linear segment. It has no central furrow, such as exists in *A. Fischeri*, nor any crenulate border in front; indeed, the front margin must have been very narrow, as our figure (woodcut 17) indicates.

FIG. 17.



The cheeks are triangular and gently convex, strongly and rather deeply marginal, the margin being not so broad externally as in *A. Fischeri*, and the cheek consequently more triangular and less oblong. The eye is placed far inwards for the genus, and only one third up the cheek. We have not the actual eye. It was small, but is not preserved in our specimen. The facial suture curves largely out and upward beyond the eye, and cuts the obtuse head-angles.

As the glabella is more convex than usual in the genus, so is the axis of the thorax which follows it, and which is not so wide as the sides, but wider in proportion than other species. The pleuræ are each convex, especially within (in the cast), and have the fulcral point at one third, whence they bend backward and curve downward. No pleural groove shows on the exterior surface, but within the crust the furrow is visible on the anterior edge of the segment.¹ The extremities are curved, and apparently rounded, but this last may be deceptive.

The tail is remarkable, and in our largest specimen (fig. 30) shows well the characters which separate it from *A. Fischeri*. Its parabolic flattened axis, divided into five rings, reaches barely more than half the length, divided by only faint axial furrows from the five side pleuræ, of which four are well distinct on each side, and have a sublinear but some-

¹ This is usual in all genera with ungrooved pleuræ, and hence the distinction of those groups which have "plevre à sillon," from those which have "plevre à bourrelet" is an artificial one. Cheirus and Sphærexochus show the intermediate character.

what clavate form, the truncate ends being oblique. The two terminal ones close so completely behind the axis that the suture is soldered, and they appear as a single rectangular plate, with a terminal notch only. The whole tail is gently and regularly convex, and the appearance thus given is very peculiar.

Locality—CARADOC SLATE of Tramore, County Waterford (Mus. P. Geol.).

AMPHION BENEVOLENS, n. sp. Pl. VI, fig. 31.

A. minor, capite (solùm cognoto) lentè convexo, latimarginato, margine frontali incrasato nec crenulato. Glabella lentè convexa anticè latior, lobis longis transversis, antico abbreviato triangulari, vix plus quam dimidium frontis efficiente; sulco centrali nullo. Oculi retrorsi, à glabellâ paullum remoti. Reliqua absunt.

Much more nearly like the Russian species than the one above described. *A. benevolens*, named in honour of Mr. Nevins, of Waterford, differs from that species in its proportions, and in the presence of a plain, thickened, anterior margin instead of the crenulate border visible in the Scandinavian fossil. It is about the same size. We have only the glabella and a part of the cheeks, which show the eye to have been also very much nearer the glabella than in the species just quoted.

Head seven lines long and about fourteen wide, semicircular, a little pointed in front, gently and regularly convex, the glabella being just as long as broad above, and tapering slowly behind—the axal furrows quite straight. A thick margin runs round the front, quite free from corrugations, and with a small tubercle in the centre, the division between this margin and the glabella being feeble for the extent of the forehead-lobe, which occupies rather more than half the whole width of the glabella in front, and has a pair of very oblique, faint, straight furrows to bound it. Outside this the marginal furrow is as deep (in the cast, which is all we possess) as the abrupt axal furrows of the head. The middle and basal furrows are long, reaching more than one third across the glabella; the middle one straight at first, then gently decurved, the lower one quite straight, and all of them deepest at their inner termination. The neck-furrow rises considerably toward the middle, so as to make the basal lobes cuneate, but neither the neck-segment nor any of the lobes are tumid. All partake of the regular and gentle convexity of the head.

The eye is placed opposite the median lobe; it is small, but elevated, and surrounded by a rather deep furrow, and it is only about twice as far from the glabella as from the neck-furrow (in *A. Fischeri* it is three or four times as remote).

Locality.—CARADOC SLATE of Newtown, Waterford, in company with *Phacops Jamesii*, described at p. 32.

A. PAUPER, n. sp. Pl. VI, fig. 32.

Omnino precedenti simillimus, nisi margine antico angustiore, lobis glabellæ longioribus radiatis, postico sinuato, mediano valdè obliquo recto, antico obsoleto. Glabella lentè convexiuscula, laferibus paullum arcuatis. Oculi subremoti.

One specimen only has been preserved of this neat species, which is truly distinct. It is about the same size as the preceding, from which, at a glance, you may distinguish it by the long glabella-furrows, and when closely examined it is found that there is one pair absent, viz., the obsolete anterior ones. A faint marking only indicates their proper position.

Glabella, including the narrow front border, as long as broad, regularly and gently convex, arched slightly in front; the sides not straight, but curved outwards; the upper angles rectangular. Anterior border narrow, not thickened. Anterior furrows quite obsolete. Median furrows starting from the upper angle or a little below it, straight, oblique, and reaching far towards the centre. Lower furrows situated opposite the eye, and reaching nearly as far as the upper ones. The middle lobes are thus subcuneate, the basal lobes broad-linear. The neck-furrow is distinct, but shallow; the neck-segment linear, but not so wide as the basal lobes; none of the glabella-furrows are thickened at their terminations. Axal furrows not deep. Position of eye doubtful, but probably further forward than in *A. benevolens*. The neck-furrow on the cheek is strong.

Compared with the preceding species, *A. pauper* differs in nearly every part. Instead of a thick front margin, it has a narrow one; the anterior furrows are obsolete, a very curious character, and peculiar to this species. The median ones oblique and longer than the basal furrows, which are sinuous instead of straight. Lastly, the head is less convex, and all the furrows—neck-furrow, axal-furrow, and glabella-furrows—less strong. The outline of the glabella is barrel-shaped, not rectilinear.

Locality.—One specimen only is known, from the CARADOC ROCKS of Tramore, where it occurs with the preceding (Mus. Irish Industry, B. 643).

The genera *Staurocephalus* and *Deiphon* should follow these. If we obtain good materials during the coming summer, they shall be illustrated next. If not, it will be better to proceed with the *Calymenidæ*.

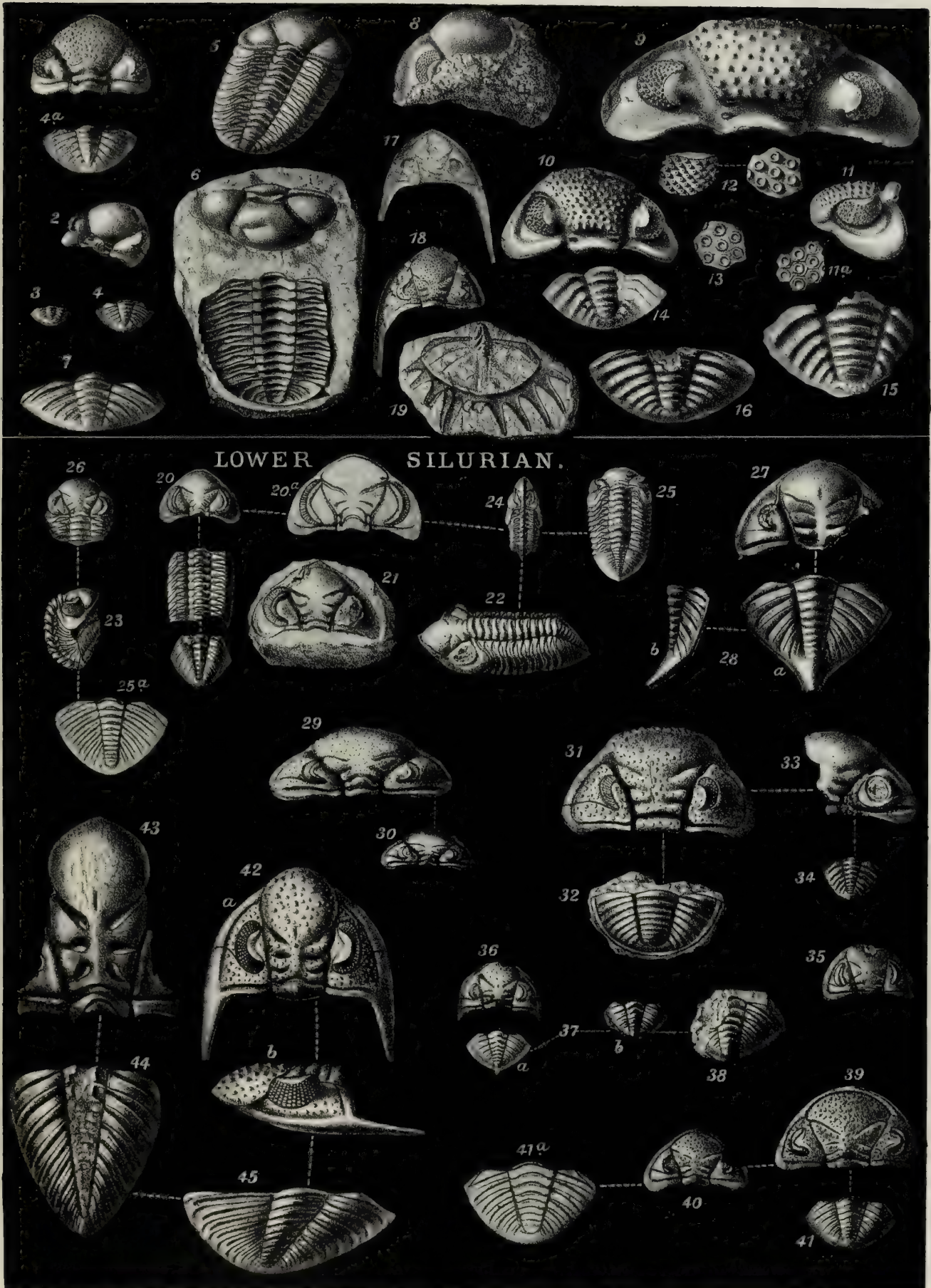
The genera *Cybele*, *Encrinurus*, and their allies, will be in like manner postponed. And the *Acidaspidæ* and *Lichadæ* may well wait awhile till the more complete materials belonging to the *Calymenidæ*, *Cyphaspidæ*, *Olenidæ*, and *Asaphidæ*, are exhausted. I think, as the families are numbered, it cannot be of great consequence which is illustrated first. But if the materials be forthcoming, it is desirable not to interrupt the natural order of the genera; and I shall do so as little as possible.

PLATE I.

DEVONIAN AND LOWER SILURIAN.

FIG.

- 1—4. *Phacops granulatus*, MÜNSTER. From Upper Devonian Rocks. Fig. 1, Newton Bushell. (Mr. Pengelly's cabinet.) Figs. 2, 3, 4, Petherwin, Cornwall. (Mus. Pract. Geology.) Fig. 4 *a* is fig. 4 enlarged.
- 5—7. „ *lævis*, MÜNSTER. Knowl Hill, near Newton Bushell. (Figs. 5, 6, Mr. Pengelly's cabinet. Fig. 7, Mr. Vicary's collection.)
8. „ *cryptophthalmus*, EMMERSON. Newton Bushell. (Mus. Pract. Geology.)
- 9—15. „ *latifrons*, BRONN. From the Uppermost Devonian or Pilton Group, near Barnstaple. Figs. 9, 10, somewhat distorted. (Mus. Pract. Geology.) (Fig. 11, cabinet of Mr. Townshend Hall.) Fig. 11 *a*, eye, with spaces between the lenses marked out into hexagonal areas on the inner cast. Fig. 12, specimen with very prominent cups in the inner cast, *i. e.* with thickened cornea. Fig. 13, specimen with thinner cornea and less prominent cups. Fig. 14, Baggy Point, N. Devon. (Mus. Pract. Geol.)
16. „ „ Variety with narrower axis and more side ribs. Newton Bushell. (Mus. Pract. Geology.)
- 17—19. *Phacops punctatus*, STEININGER. Liskeard. (Figs. 17, 18, Mr. Pengelly's cabinet. Fig. 19, Mus. Pract. Geology.)
20. „ *Brongniartii*, PORTLOCK. Montgomeryshire, Lower Silurian. (Mus. Pract. Geology.)
- 21—25. „ „ From Tyrone. Portlock's figured specimens. 25 *a*. Magnified.
26. „ „ Variety or ♀ form. (*P. Dalmani*, Portlock, figured specimen.)
- 27, 28. *Phacops incertus*, DESLONGCHAMPS. Lower Silurian pebbles of Budleigh Salterton, S. Devon. (Mr. Vicary's cabinet.)
- 29, 30. „ *Jukesii*, SALTER. N. Wales. (Mus. Pract. Geology.) Caradoc Rocks.
- 31, 32. „ *alifrons*, Id. From N. Wales (copied from figures in the Woodwardian Synopsis).
- 33, 34. „ „ „ N. Wales (from specimens in the Mus. Pract. Geology.) Caradoc.
35. „ *mimus*, Id. Quartzite of Gorran Haven, Cornwall. (Mus. Pract. Geology.) Llandeilo Rocks?
- 36—38. „ *apiculatus*, SALTER. Horderley, &c., Shropshire. Caradoc. (Mus. Pract. Geology.)
- 39—41. „ *Jamesii*, PORTLOCK. Figured specimens, Waterford. Caradoc. (Mus. Pract. Geology.)
- 41 *a*. „ „ „ Tail of the same, magnified.
42. „ *obtusicaudatus*, SALTER. Fine specimen in the Woodwardian Museum, from Coniston Flags. Caradoc Rocks.
- 43—45. „ „ Varies distorted specimens. (43, 44, Brit. Mus. 45, Mr. Edgell's cabinet.)



1 *P. (P.)* *gawwanti* 2 *P. (P.)* *gawwanti* 3 *P. (P.)* *gawwanti* 4 *P. (P.)* *gawwanti* 5 *P. (P.)* *gawwanti* 6 *P. (P.)* *gawwanti* 7 *P. (P.)* *gawwanti* 8 *P. (P.)* *gawwanti* 9 *P. (P.)* *gawwanti* 10 *P. (P.)* *gawwanti* 11 *P. (P.)* *gawwanti* 12 *P. (P.)* *gawwanti* 13 *P. (P.)* *gawwanti* 14 *P. (P.)* *gawwanti* 15 *P. (P.)* *gawwanti* 16 *P. (P.)* *gawwanti* 17 *P. (P.)* *gawwanti* 18 *P. (P.)* *gawwanti* 19 *P. (P.)* *gawwanti* 20 *P. (P.)* *gawwanti* 21 *P. (P.)* *gawwanti* 22 *P. (P.)* *gawwanti* 23 *P. (P.)* *gawwanti* 24 *P. (P.)* *gawwanti* 25 *P. (P.)* *gawwanti* 26 *P. (P.)* *gawwanti* 27 *P. (P.)* *gawwanti* 28 *P. (P.)* *gawwanti* 29 *P. (P.)* *gawwanti* 30 *P. (P.)* *gawwanti* 31 *P. (P.)* *gawwanti* 32 *P. (P.)* *gawwanti* 33 *P. (P.)* *gawwanti* 34 *P. (P.)* *gawwanti* 35 *P. (P.)* *gawwanti* 36 *P. (P.)* *gawwanti* 37 *P. (P.)* *gawwanti* 38 *P. (P.)* *gawwanti* 39 *P. (P.)* *gawwanti* 40 *P. (P.)* *gawwanti* 41 *P. (P.)* *gawwanti* 42 *P. (P.)* *gawwanti* 43 *P. (P.)* *gawwanti* 44 *P. (P.)* *gawwanti* 45 *P. (P.)* *gawwanti*

PLATE II.

UPPER SILURIAN.

FIG.

1. *Phacops Stokesii*, MILNE-EDWARDS. Abberley Hills, Wenlock Shale. (Mus. Pract. Geology.)
- 2—5. " " From Dudley. (Mr. Mushen's cabinet.) 2 *a*. Head, enlarged (3 *a* is 3 magnified). 4. Tail. 5. Eye, magnified.
6. *Phacops Stokesii*. Locality uncertain. Wenlock Shale of N. or S. Wales. (Mus. Pract. Geology.)
- 7—10. " *Musheni*, SALTER. Of various ages; from the Wenlock Shale, Malvern. 9 *a*. Tail, enlarged. (Cabinets of J. Mushen, Esq., and C. Ketley, Esq.)
- 11, 12. " " Larger specimens, Dudley. (Gray collection, Brit. Mus.)
- 13, 14. *Phacops constrictus*, SALTER. Wenlock Shale, Malvern. 13 *a*. Tail, enlarged. (Dr. Grindrod's cabinet.)
15. " " (15 *a*, side view; 15 *b*, magnified.) 15 *c*. Eye of the same species. (Mr. Ketley's cabinet.)
16. " " The same species. Wenlock Limestone; Dudley. (Brit. Mus.)
- 17—25. *Phacops Downingia*, MURCHISON, var. *a*, *vulgaris*. All from Dudley and Walsall. Fig. 17, a cluster, in the Brit. Mus. Figs. 18, 25, the specimens figured in the original 'Silurian System,' and now in the cabinet of Mr. W. Mathews, junr., of Edgbaston. Fig. 19, half-coiled specimen (Professor Tennant's coll.). Fig. 20, completely coiled (Decades of Geol. Survey). Fig. 21, young ditto (Mr. Mushen's cabinet). Figs. 22, 23, large specimens (Brit. Mus., Gray coll.). Fig. 24, form with large eyes, Malvern, in Wenlock Shale. (Mr. Ketley's cabinet.)
- 26—29. " " Large-eyed variety, β , *macrops*. Fig. 26 is copied from the Survey Decades. Fig. 27, large specimen, Malvern, Wenlock Shale. (Mr. Ketley's cabinet.) Fig. 28. Dudley. (Brit. Museum.) Fig. 29, internal cast, from Wenlock Rocks, near Cardiff. (Mus. Pract. Geology.)
30. " " var. γ , *inflatus*. Malvern Limestone. (Dr. Grindrod's cabinet.)
- 31—32. " " Probably the same variety. Fig. 31, certainly so (glabella only), from Ledbury. Fig. 32, internal cast, same locality. Both are figured in the Decade 7, Geol. Survey, and are in the Mus. Pract. Geology.
33. " " Interior cast of tail. Eastnor, near Ledbury. (Mus. Pract. Geology.) Wenlock Limestone.
34. " " Dissection of the species. (Decades Geol. Survey.) *a*. Anterior ring, bearing the eyes. *b*. Underside of head (hypostome), bearing the labrum. *c*. Glabella and fixed cheeks. *d*. Magnified eye. *e*. Lenses and interstitial granules, still more magnified. *f*. Casts of the cups which support the lenses. *g*. Thorax-joints. *h*. Underside of the pleuræ of ditto. *i*. Tail of ditto. All more or less enlarged.

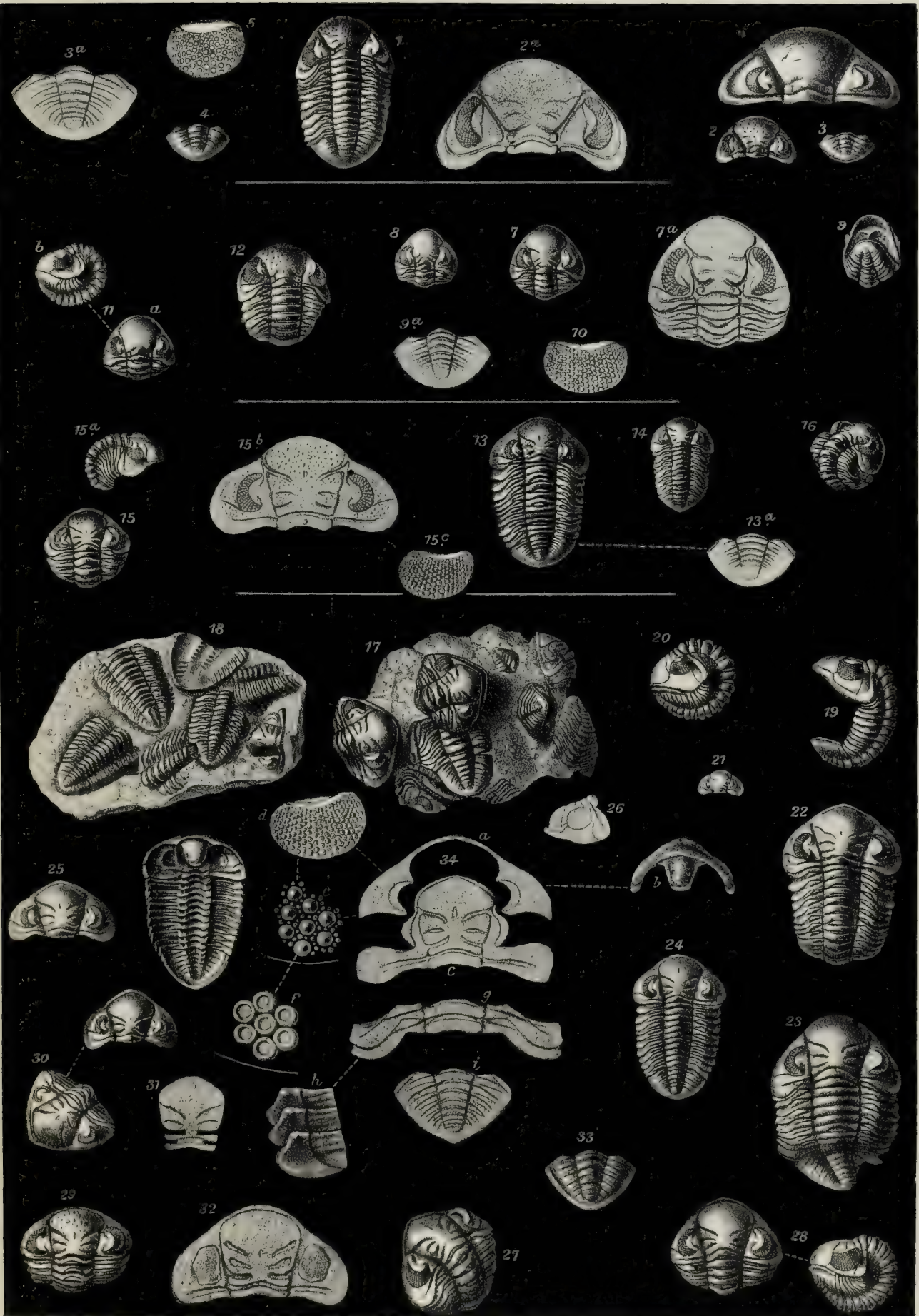




PLATE III.

UPPER SILURIAN.

FIG.

- 1, 2, 3. *Phacops Weaveri*, SALTER. Figs. 2, 3, are from (May Hill? or) Ludlow Rocks, Horseshoe Farm, Tortworth. Fig. 1, the head, is added from the May Hill Rock of the neighbourhood to complete the figure of the species. (Mus. Pract. Geology.)
- 4—14. „ *caudatus*, var. α . Various figures of ordinary variety, *vulgaris*, young and old, from Dudley. Fig. 4, Mr. Mushen's cabinet, Rushall Canal. Fig. 5, British Museum. Fig. 6, interior cast, Ledbury. (Mus. P. Geology.) Figs. 7, 8, labrum, from Mr. Mathews' and Mr. Ketley's cabinets. Fig. 9, side view of head, Dudley. (Mus. Pract. Geology.) Fig. 10, eye (Dr. Grindrod's cabinet), Ledbury. Fig. 11, same, magnified. Fig. 12, interior cast, Ledbury (Mus. Pract. Geology), shows the casts of the interior of the gland-like tubercles (see p. 52), such as are seen on the exterior of figs. 16, 17. Fig. 13, large but worn Dudley specimens (in Brit. Mus.), figured by König under the name of *Asaphus myops*. Fig. 14, fine interior, in Mr. Mushen's cabinet.
15. „ „ Young (Brit. Mus.), showing the central tubercles.
- 16, 17. „ „ Dwarf specimens, retaining the characteristic tubercles of the young state; Ledbury. (Fig. 16, from my own cabinet. Fig. 17, Mus. Pract. Geology.)
18. „ „ var. δ , *aculeatus*. Wren's Nest, Dudley (Mr. Ketley's cabinet). All the above are from the Wenlock Limestone.
- 19—28. *Phacops longicaudatus*, MURCHISON. Figs. 19—21, ordinary variety, α . Figs. 22—28, short-tailed variety, β . All from Wenlock Shale. Figs. 19, 20, are Burrington specimens. (Mus. Pract. Geology.) Fig. 21, Brit. Mus. Fig. 22—25 are from the Wenlock Shale of the Malvern Railway. (Mr. Mushen.) Fig. 23, Dr. Grindrod. Fig. 26, Brit. Mus. Fig. 27 is from the Rushall Canal. (Mr. Mushen's cabinet.)

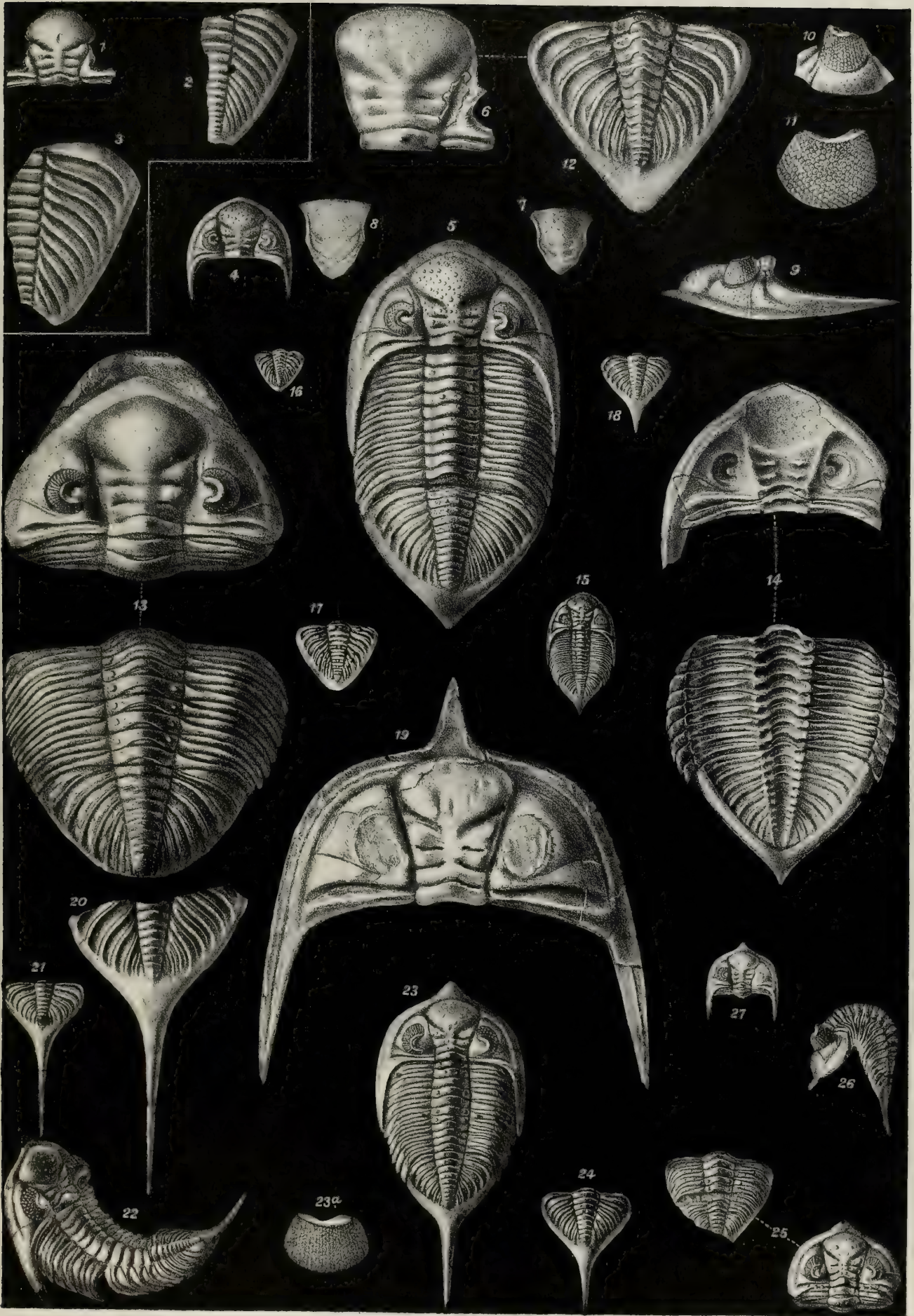




PLATE IV.

UPPER AND LOWER SILURIAN.

- Fig.
 1. *Phacops caudatus*, var. β , *tuberculato-caudatus*. A large and fine specimen in Dr. Grindrod's cabinet, Lower Ludlow, Malvern.
2. „ *caudatus*, junior. Mr. Mushen's cabinet, Dudley.
- 3, 4, 5. „ „ var. γ , *newilis*. Vinnal Hill, Ludlow. (Mus. P. Geology.)
- 6—9. „ *Weaveri*, SALTER. Fig. 6, imperfect head from Tortworth. (Mus. P. Geology.) Fig. 7, tail, ordinary size, Tortworth. Figs. 8, 9, tails of mucronate variety, May Hill Schist, Marloes Bay, Pembrokeshire. (All in Mus. P. Geology.)
10. *Phacops imbricatulus*, ANGELIN? May Hill Rocks, Presteign. (Mus. P. Geology.)
- 11, 12. „ *mucronatus*, BRONGNIART. From near Bala. (Mus. Pract. Geol.)
- 13—15. „ *truncato-caudatus*, PORTLOCK, his original figured specimens. Fig. 13, natural size. Fig. 14, restored figure, reduced size. Fig. 15, labrum. All from the Caradoc of Desertcreat, Tyrone. (Mus. Pract. Geology.)
- 16, 17. „ *amphora*, SALTER. Grug, near Llandeilo. (Mus. Pract. Geology.)
- 18—23. „ *macroura*, SJOGREN. From the Caradoc of Acton Scott, &c., Shropshire. Figs. 18, 19, adult head and tail. (Ludlow Museum.) Fig. 20, external cast of head, middle age. (Mus. Pract. Geology.) Fig. 21, labrum (Ludlow Museum), showing the perforation *a*, which marks the place of the ascending process. Fig. 22, perfect tail, and fig. 23, very young tail, pointed. (Ludlow Mus.)
- 24, 25. „ *conophthalmus*, BOECK? Fig. 24, young heads. (Mr. Lightbody's cabinet.) Fig. 25, internal cast of head from Llansantffraid Glyn Ceiriog, N. Wales. (Woodwardian Museum); for figure of tail from same locality, see Pl. VI, fig. 25.

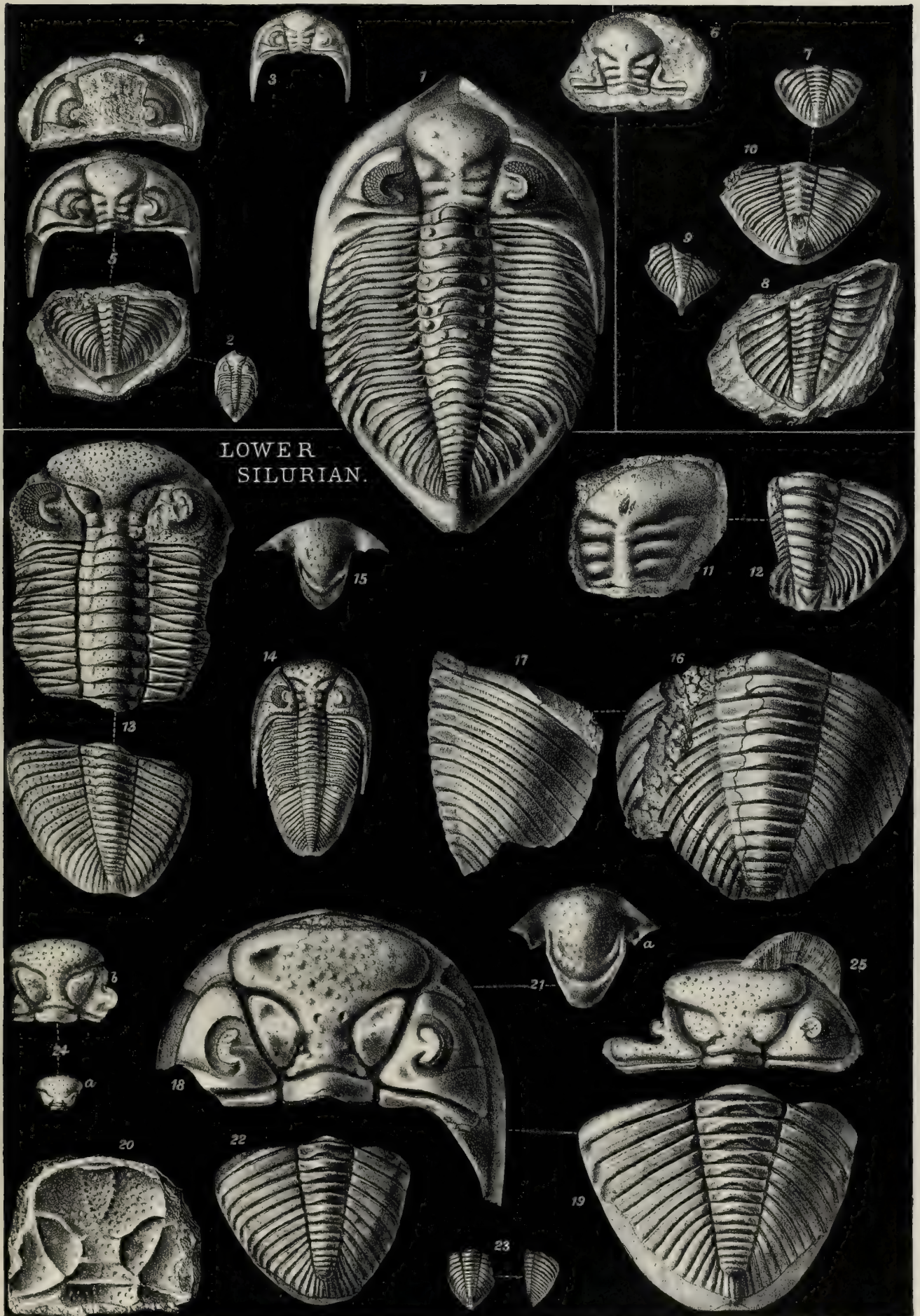


TABLE V.

LOWER SILURIAN.

FIG.

- | | | |
|--------|--|--|
| 1. | <i>Cheirurus bimucronatus</i> , MURCH. | Large internal cast from Caradoc Strata, Sholeshook, Pembrokeshire, also figured in Memoirs of Geol. Survey, vol. ii, pt. 1, pl. vii, fig. 4. (Mus. Pract. Geol.) |
| 2. | „ „ „ | Smaller head, external surface, Caradoc Strata, Chair of Kildare. (Mus. Pract. Geol.) |
| 3. | „ „ „ | Young. May Hill Sandstone of Norbury. (Mr. W. Edgell's cabinet.) |
| 4. | „ „ „ | Young, distorted (<i>Ceraurus Williamsii</i> , McCoy, figured specimen), Llandovery Rock, Llandovery. (Woodw. Mus.) |
| 5. | „ „ „ | Labrum of large specimen, Chair of Kildare. (Mus. Pract. Geol.) |
| 6—8. | „ <i>gelasinosus</i> , PORTLOCK. | Fig. 6, tolerably perfect surface of Ayrshire specimen. (Mus. Pract. Geol.) Figs. 7, 8, Portlock's figured specimens from Tyrone. Both are Caradoc localities. |
| 9—12. | „ <i>juvenis</i> , SALTER. | Fig. 9, exterior of glabella, Chair of Kildare. Fig. 10, internal cast, Sholeshook, Pembrokeshire. Fig. 11, side view of same. Fig. 12, tail from Chair of Kildare. Caradoc Beds. (All from Mus. Pract. Geol.) |
| 13. | „ <i>octolobatus</i> , MCCOY. | Caradoc of Penwhapple, Ayrshire. (Brit. Mus.) |
| 14. | „ „ | The same, tail from Rhiwlas, Bala. (Mus. Pract. Geol.) (Probably this is the <i>C. clavifrons</i> , Dalman; <i>C. affinis</i> , Angelin.) |
| 15. | „ <i>cancrurus</i> , SALTER. | Originally described specimen, from the Chair of Kildare. (Mus. Pract. Geol.) |
| 16. | „ „ ? | Chair of Kildare. (Sir. R. Griffith's coll.) |
| 17. | „ <i>Sedgwicki</i> , MCCOY. | Llandeilo Flags of Builth. (Woodwardian Museum.) |
| 18—20. | „ <i>Frederici</i> , SALTER. | Upper Tremadoc Slate of Portmadoc, N. Wales. (Fig. 18, Mr. D. Homfray's cabinet. Fig. 19, Mr. Ash's cabinet. Fig. 20, Mus. Pract. Geol.) |
| 21. | „ <i>Frederici</i> ?, variety. | Same formation and locality, Garth Hill, Portmadoc. (Mr. D. Homfray's cabinet.) |

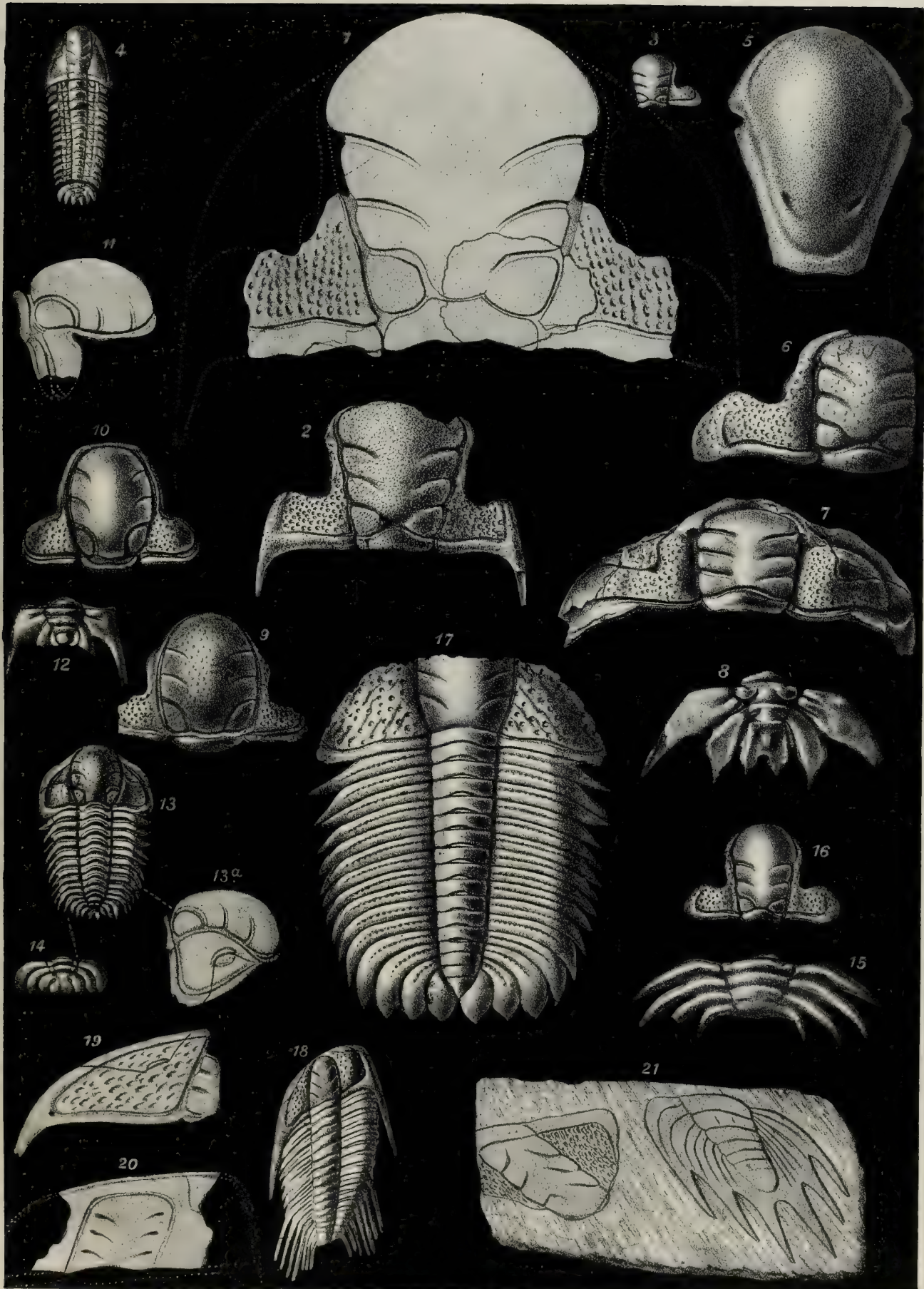


TABLE VI.

UPPER AND LOWER SILURIAN.

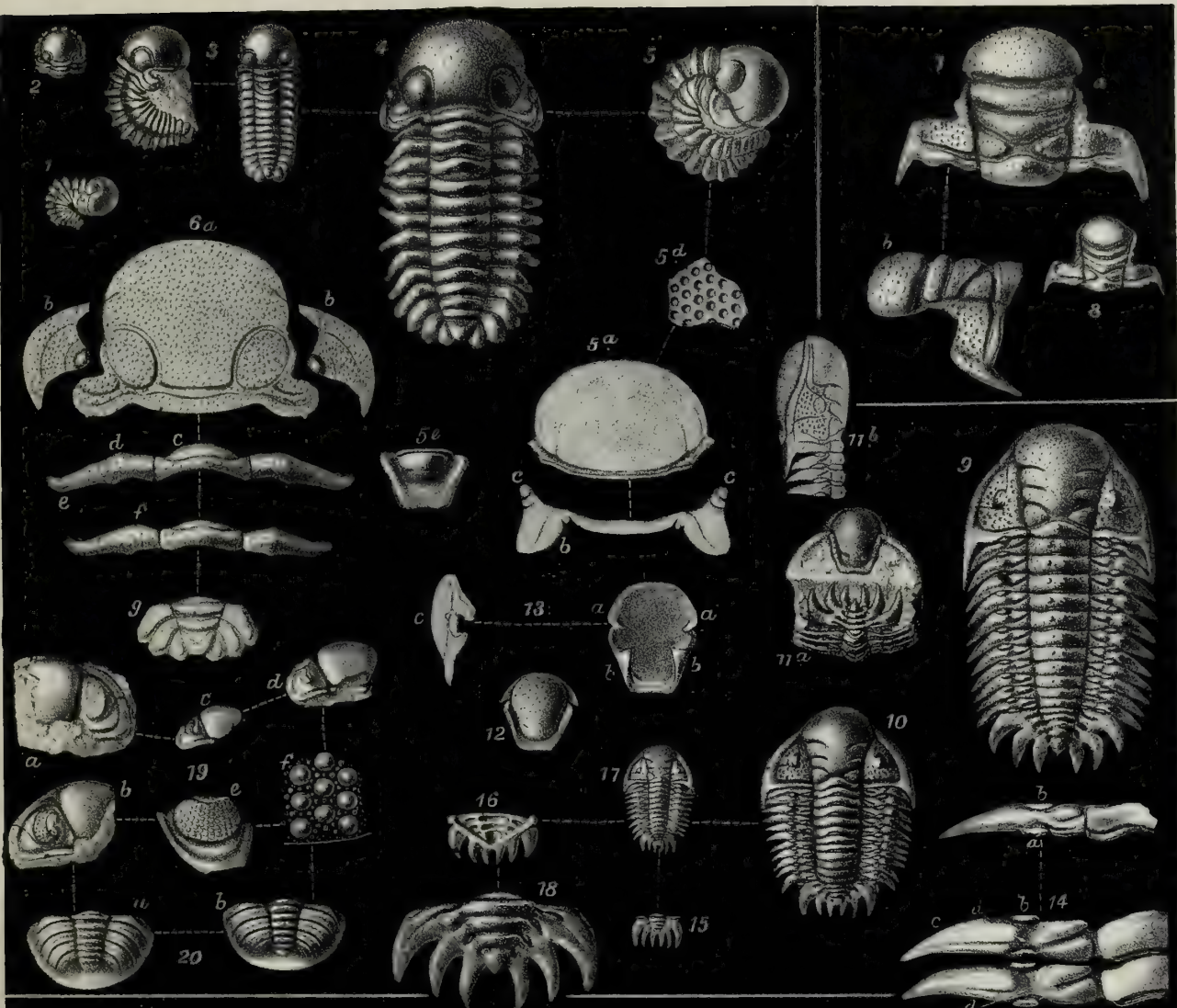
UPPER SILURIAN.

FIG.

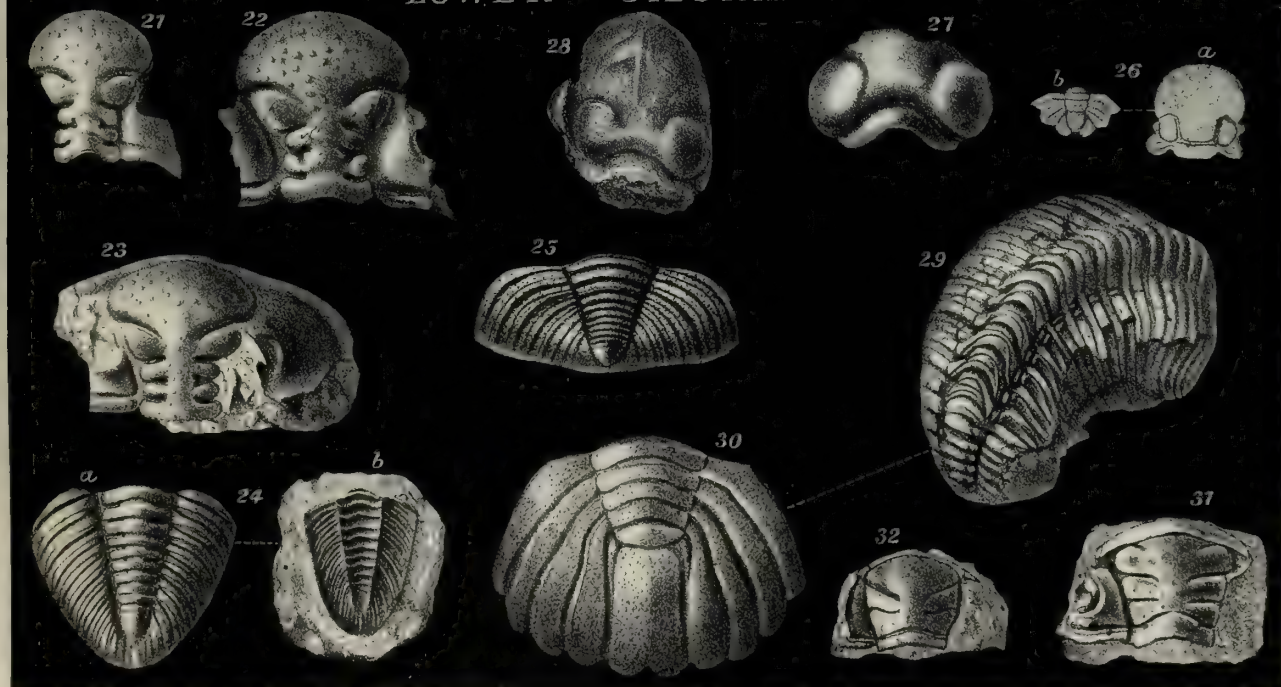
1. *Sphærexochus mirus*, BEYRICH. Dudley. (Mr. Shedden's cabinet.) Young coiled specimen.
- 2, 3, 4. " " Of various ages. From the Wenlock Shale of Malvern Tunnel. (Dr. Grindrod's cabinet.)
5. A coiled-up specimen. (Brit. Mus., Gray coll.) 5 *a*. The head, dissected, front view, showing the anterior glabella-furrows, and at *b* the anterior segment, the cheeks connected by the hypostome, without the intervention of a rostral shield. *c*. The convex eye. *d*. The lenticular surface, magnified, the lenses removed.
6. The same viewed dorsally, and showing the strong basal glabella-furrows, the surface finely granular. *b*. The cheeks. A minute tubercle indicates the place of the head-spines. *c*. A body-ring, third or fourth, showing the position of the fulcrum (*d*), and the prominence behind, against which the fulcrum abuts. *e*. Incurved tip of pleura. *f*. Last thorax-segment, the fulcrum near the axis. In this and the preceding figure the pleuræ are represented as flattened out to show their characters; they would appear much shorter on viewing them from above. *g*. The tail, magnified. (Figs. *c* to *g* are from Capt. T. Fletcher's Dudley collection, now in the Fitzwilliam Museum, Cambridge.)
- 7, 8. *Cheirurus articulatus*, MÜNSTER. A large and a small head from Mr. Pengelly's cabinet. From Lammaton, Torquay, in Middle Devonian Limestone.
9. " *bimucronatus*, MURCHISON, var. β . A half-grown but very perfect specimen. (Cabinet of Mr. E. Hollier, junr.) Dudley.
10. A fine specimen, shortened by pressure, from Mr. Ketley's collection. Same variety,— β .
- 11 *a*, *b*. A Malvern specimen, cleared by Mr. C. Ketley, and now in his cabinet. It shows the labrum and the central mucro to the tail, var. *a*. 11 *b*. Side view of ditto.
12. Labrum, also from Mr. Ketley's cabinet.
13. Shows the interior view of the same organ. At *a*, *a*, the ascending processes, which are attached to the sides of the glabella. *b*, *b*. The incurved triangular plates. There is a hollow space under the ascending processes, answering to the lateral notch on the upper surface (fig. 12).
14. Pleuræ of *C. bimucronatus*, from a specimen in Mr. Mushen's cabinet. The lower figure is an internal cast of ditto, copied from the Decades of the Survey. *a*. The posterior fulcral tubercle. *b*. The anterior tubercle. *c*. Free tip of pleura. *d*. Cast of vertical ridge on interior surface.
- 15, 16. Tails of young specimens, var. α . Dudley collections.
17. Entire young specimen, var. α . (Mr. Mushen.) Dudley.
18. *C. bimucronatus*, var. β , *centralis*. Dudley. (Mr. E. Hollier, junr.) (Figs. 19—24 are from the Mus. Irish Industry.)
- 19, 20. *Phacops nudus*, SALTER. *a*, *b*, *c*. Fragmentary heads. Fig. *d* is *c* magnified. *e*. Eye, magnified. *f*. The lenses, magnified. Fig. 20, tails, two specimens. Upper Silurian Limestone, Dingle, Co. Kerry.

LOWER SILURIAN.

- 21—24. *Phacops Bailyi*, SALTER. Caradoc of Tramore, Co. Waterford. 24 *a*. Interior cast of tail. *b*. Exterior cast.
25. " *conophthalmus*, BOECK.? Caradoc, N. Wales. (Cambridge Museum.)
26. *Sphærexochus mirus*, BEYRICH. Caradoc, Chair of Kildare. (Mus. Pract. Geology.)
- 27, 28. " *boops*, SALTER. Caradoc. Haverfordwest. Fig. 27 (Mus. P. Geol.). Fig. 28, Westmoreland. (Cambridge Museum.)
- 29, 30. *Amphion pseudo-articulatus*, PORTLOCK. Caradoc of Tramore, Waterford. (Mus. Pract. Geology.)
31. " *benevolens*, SALTER. Caradoc of Newtown, Waterford. (Mus. Pract. Geology.)
32. " *pauper*, SALTER. Caradoc of Tramore. (Mus. Irish Industry.)



LOWER SILURIAN.



THE

PALÆONTOGRAPHICAL SOCIETY.

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MDCCCLXIV.

A MONOGRAPH
OF
BRITISH
DEVONIAN BRACHIOPODA.

BY
THOMAS DAVIDSON, ESQ., F.R.S., F.G.S.,
ETC. ETC

PART VI.
FIRST PORTION.

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A MONOGRAPH

OF

BRITISH DEVONIAN BRACHIOPODA.

PRELIMINARY REMARKS.

BETWEEN the Upper Silurian and Lower Carboniferous series of deposits there exists a very extensive formation, to which the designation of OLD RED SANDSTONE or DEVONIAN SYSTEM has been given. This formation, composed of numerous alternations of sandstone (chiefly red), shale, slate, and limestone, is largely developed in several of the counties of Great Britain, and especially in those of Devonshire and Cornwall, whence most of the examples of Brachiopoda figured in this monograph have been derived.

In the present monograph on the British Devonian Brachiopoda, I purpose to commence with illustrating their many and varied forms, and to reserve, until a future occasion, any remarks upon their local and general distribution. Before, however, entering into these details, I would direct attention to the following observations of Professor Ramsay, given in his Anniversary Address to the Geological Society of London, on the 20th of February, 1863, as being the most recent views published upon the subject.

“*Devonian Rocks*.—Excepting that they are arranged in a given order of superposition, there is little to be said respecting the relation of the fossils to the stratigraphical relations of the Devonian rocks of the south-west of England. When, many years ago, that area was mapped, extreme analyses in geological surveying had scarcely been introduced; and in that country, consisting so largely of granite and gneiss, contorted greywacke and limestone, no one attempted on maps to split up the Devonian series into distinct sub-

formations. So exceedingly disturbed are the strata, that without a new survey it is to this day impossible to say what unconformities may or may not exist among its members. Neither, till the country is remapped, is it possible to make out accurately the exact zoological relations of the subdivisions; and the data I now present are only approximate, being the result of an examination of the Devonian lists with Mr. Salter, who placed his intimate knowledge of the ranges of Palæozoic forms at my disposal.

“First, then, the Devonian fossils are distinct from those of the Silurian rocks of the district, a circumstance easily accounted for when we know that they lie directly and unconformably on Lower Silurian strata.

“This, therefore, makes it impossible to prove that in Devon or Cornwall the lowest Devonian rocks exist. In North America, where such beds lie directly on Upper Silurian strata, it is plain that the latter suffered extensive erosion before the deposition of the former, this physical break being accompanied by a marked break in organic succession. There is thus reason to believe that, if our Upper Silurian strata were in contact with the Lower Devonian rocks of Devon and Cornwall, the same broken relations would exist between them; for of the several hundreds of Upper Silurian forms, it is said that only about six species occur in the Lower Devonian rocks, perhaps not more than 1 per cent.

“Thus, therefore, we have a zoological break, all but total, between two formations, accompanied, probably, by a vast lapse of time unrepresented by any strata in Devonshire, and only *possibly* represented by the so-called unfossiliferous Lower Old Red Sandstone of Ireland, Scotland, and Wales.

“There being, in Mr. Salter’s opinion, no marked zoological line between our Lower and Middle Devonian orders, I have massed them, and divided the series as follows:—

“1. Marwood and Pilton beds = the Coomhola Grits of Mr. Jukes and Carboniferous Slate of Sir R. Griffith.

“2. Upper Devonian strata.

“3. Middle and Lower Devonian.

“The result of an elaborate analysis from tables prepared for the purpose, is that of known Middle and Lower Devonian fossils there are about 61 genera and 170 species; and of these about 23 species only pass into the Upper Devonian division, or about 13½ per cent.

“The Upper Devonian beds yield about 30 genera and 70 species; and of these 24 (or about 34 per cent.) pass into the Marwood beds, which in Devonshire have heretofore given about 31 genera and 65 species, of which 14 species, or about 21 per cent., pass into the Carboniferous rocks. Judged by the imperfect data of mere per-centages, it appears, then, that the Upper Devonian are less intimately connected with the Lower Devonian than with the Marwood beds, and that the Marwood beds are zoologically more nearly related to the Upper Devonian than to the Carboniferous strata. In the south-west

of Ireland the Coomhola grits and Carboniferous slate pass downwards into Old Red Sandstone, and upwards into Carboniferous Limestone; and they are considered by Mr. Jukes either to be the lowest part of the Carboniferous series, or else to form a distinct group together with the upper half of the Irish Old Red Sandstone, which is stratigraphically quite unconnected with the lower half. Further, it must be remembered that for many years, in Devon and Cornwall, Silurian and Devonian rocks were all massed together and called by one name. But we know that there must be an unconformity discoverable between the Lower Silurian and Devonian rocks, if properly searched for; and analogy would lead us to expect, from the strong breaks in organic succession, that the same broken stratigraphical relations—lapses of unrepresented time—must exist between the various members of the typical Devonian series, just as they certainly occur in what geologists consider their equivalents, the Old Red Sandstones of Scotland and of Ireland.”¹

Mr. Pengelly, whose knowledge of Devonshire and Cornwall Devonian Geology is very considerable, informs me that, according to Professor Sedgwick’s system, (‘Quart. Journ. Geol. Soc.,’ vol. viii,) the slates and limestones of North Devon and Cornwall, as those of Looe, Woolborough, Ramsleigh, Hope’s Nose, Glampton Creek, Glampton Point, Black Hall, St. Veep, Polruan, and Whitesand Bay, belong to the lowest Devonian group found in the two counties; that he followed him in his paper on the distribution of the fossils of

¹ The late D. Sharpe, writes in June, 1852 (‘Journ. Geol. Soc.,’ vol. ix, p. 22), that he urged Mr. Morris, in 1843, to separate from the Devonian system the fossiliferous beds of Pilton and Barnstaple (and, perhaps, Marwood) in North Devon, and those of Tintagel and South Petherwin in the South, and to place them in that group of strata which corresponds to the Lower Limestone-shales of Northumberland and the Scotch coal-field.

Mr. Salter thus classes the North Devon strata in *descending* order.

I. PILTON BEDS.—An alternating series of calcareous sandstones and grey shales, with their bands of limestone and grey slate, full of fossils, several hundred feet thick.

II. MARWOOD BEDS.—A thick series of greenish-grey grits, with bands of *Cuculæa* and *Avicula* in abundance, with olive slate in which a *Lingula* occurs plentifully (both Mr. Salter and Sir H. de la Beche make the *Lingula*-beds to be *older* than the Pilton group), they run parallel with, and in close proximity to the *Cuculæa*-beds.

III. MORTE GROUP.

No Devonian Brachiopoda have been found in Scotland. The Dron Shales form a small patch in Lower Strathearn, dipping southwards into the base of the Ochils and towards the coal-fields of Fife, but separated by the entire breadth of the Ochils and the Old Red plains of S. Watheden. Mr. D. Page, Professor Harkness, Mr. Salter, Mr. Powrie, Professor R. Jones, Mr. Etheridge, and myself, are inclined to regard them as Lower Carboniferous, and not Devonian, as some have supposed. They contain but a single species of Brachiopoda, which appears referable to *Rhynchonella pleurodon*: the other organisms, although generally very imperfectly preserved, are of a Carboniferous type, *Leperditia subrecta* (Portlock’s *Cypris subrecta*), a common Lower Carboniferous fossil, having been also recognised by Mr. Jones.

The Devonian formation is largely represented in Ireland, and especially in the southern portion of the island; but, with the exception of a few localities wherein plants, fish-scales, and *Anodon Jukesii* have been found, it is non-fossiliferous, and I have not heard of any Brachiopod having been hitherto met with.

Devon and Cornwall, in the 'Geologist,' vol. v, p. 10, &c., but that neither Professor Sedgwick nor himself intend by this to express any opinion respecting the co-ordination of these Devonian rocks with those of the Devonian system elsewhere. Mr. Pengelly would, however, arrange the localities represented by the fossils he sent for my examination as below, in descending order:—

Barnstaple, Baggy, Tintagel ?	Transition or Devonian-Carboniferous Beds,
Tintagel ?, Petherwin	Upper Devonian of Devon and Cornwall,
Lummaton, Woolborough, Ramsleigh ?, Hope's Nose ?, Galmpton or Warren Point	} Middle Devonian of Devon and Cornwall,
Looe, Meadfoot, Galmpton Creek, Black Hall, St. Veep, Polruan, Whitesand Bay	
	} Lower Devonian of Devon and Cornwall = Upper Old Red of Scotland,

but that he would not be surprised to find the Hope's Nose beds belonging somewhat higher; that Ramsleigh, though very near Woolborough, has little in common with it. It certainly yields in great plenty the coral *Acervularia pentagona*, which Murchison marks a characteristic fossil in his "Middle Devonian," but, so far as he knows, this organism is not found elsewhere in the district; moreover, the Upper Silurian coral, *Chonophyllum perfoliatum*, occurs at Ramsleigh but in no other Devonian locality, so the locality is rather a puzzling one.

Professor L. de Koninck considers that the Torquay beds correspond to the psammites of the Rhine, while those of Newton would represent those of the Eifel. The Devonian formation is therefore composed of a very remarkable series of deposits, which have attracted much interest in this country as well as upon the Continent and in America, and been the subject of many important researches and works by some of our most able geologists and palæontologists, among whom we may mention Sir H. De la Beche, Sir R. Murchison, Sir C. Lyell, Professors Phillips, Sedgwick, M'Coy, Schnur, Hall, and Jukes; Viscount d'Archiac and M. De Verneuil; Drs. Sandberger, Messrs. Godwin-Austen, Lonsdale, Pengelly, Weaver, Kelly, Sowerby, H. Miller, Salter, Schlotheim, F. Roemer, Baron Von Buch, and others, whose labours and works will be alluded to in the sequel.

The material I have been able to examine in connection with this monograph has been considerable, but has not always been so good in quality as in number of specimens; and this may be easily accounted for when we remember how many of our Devonshire and Cornwall fossils have been contorted and put out of shape from the effects of cleavage and pressure, and that a large proportion of the fossils are found in the state of imperfect internal casts, or obscure fragments and impressions, at times completely undeterminable. It is in the limestone of the Middle Devonian, especially from the neighbourhood of Newton Abbot, Torquay, Plymouth, and some other localities, that our most perfect specimens have been obtained; and it is a most pleasing duty to again return thanks to Sir R. Murchison and Professor Huxley for the use they have kindly enabled me to make of the valuable series of specimens preserved in the Museum of the Geological Survey of Great Britain, and where

a large proportion of the specimens described by Phillips in his work on the Palæozoic Fossils of Cornwall, Devon, and West Somerset, have been carefully preserved. I am also greatly indebted to the Council of the Geological Society of London for the loan of their valuable series of Devonian fossils, which were collected by Sedgwick and Murchison, De la Beche, Hennah, D. Sharpe, &c., and which have been partly described and figured by J. Sowerby in the fifth volume, second series, of the 'Transactions of the Geological Society.' I wish also to record my thanks to the officers of the Geological Department of the British Museum, for having allowed me to examine and draw those specimens which were required for the present monograph. Much, however, of the material was contributed from private museums. To Mr. Pengelly my thanks are due for much valuable information, as well as for the loan of his extensive series of Devonshire and Cornwall Brachiopoda. To the Rev. J. E. Lec, of Caerleon, I am indebted for the loan of his important series of Barton Middle Devonian fossils, and in which are preserved many of the original specimens described and figured by Phillips in the work already named. My sincere thanks are likewise due to Mr. R. Stewart, Hon. Sec. of the Torquay Natural History Society; to Mr. Vicary, of Exeter; Mr. Champernowne, of Dartington Hall, Totness, Devonshire; to Mr. W. Walton, of Bath; Mr. C. Spence Bate, of Plymouth; Mr. R. H. Valpy, of Ilfracombe; Mr. F. M. Hall, of Barnstaple; Mr. Symons, of Braunton; the Rev. F. Mules, of Marwood; Professor Phillips, of Oxford; Mr. Salter, and others, for much information and the loan of their fossils. Many specimens are also preserved in the Cambridge Museum, as well as in the museums of different local institutions in Cornwall and Devonshire, such as that of Taunton, which contains the collection of the late Rev. D. Williams, the Bristol Institution, that of Plymouth, Torquay, Truro, &c. I am also greatly indebted to Professor L. de Koninck, F. Roemer, and to Mr. Bouchard, for the comparison they have kindly made of some of our British Devonian species with those of the Continent.

Before proceeding further, it may be as well to mention that in the last edition of Professor Morris's 'Catalogue of British Fossils,' published in 1854, some ninety-four species (?) of British Devonian Brachiopoda have been enumerated, but it will be found by the sequel that a certain number of these will have to be located among the synonyms, and that some other important new or well-known foreign Devonian forms, such as *Uncites*, *Gryphus*, *Davidsonia Verneuilii*, *Atrypa lepida*, &c., will require to be added to our British catalogue. I must not, however, attempt to conceal that I have experienced great difficulty and uncertainty relative to the identification of some of these so-termed species, chiefly from the want of sufficiently perfect material, and, at times, insufficiency of description and illustration by several original describers. In these cases I have reproduced the original descriptions and figures, and have prefixed a point of interrogation to each description where some doubt may prevail, or where the material has not been quite sufficient to warrant a satisfactory determination.

I will not at present anticipate what I may have to say with reference to those species which are common to the Silurian, Devonian, Carboniferous, and Permian systems, as I

shall endeavour to treat that question in the concluding portion of this monograph, but will, without further observations, proceed with the description of the species we have been able to assemble.

Family—TEREBRATULIDÆ.

Genus—TEREBRATULA, *Llhwyl.*

TEREBRATULA SACCULUS, *Martin*; variety? Pl. I, fig. 1—8.

ANOMITES SACCULUS, *Martin*. Petref. Derbesiana, tab. xlvi, figs. 1 and 2, 1809.

— — *Dav.* Mon. Carb. Brach., p. 14 and 213, pl. i, figs. 23, 24, 27, 29, 30.

TEREBRATULA SACCULUS, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 91, tab. xxxv, fig. 166, 1841.

— HASTATA. Ibid., fig. 168.

— VIRGO, Ibid., fig. 167.

— SACCULUS, *A. Roemer*. Die Versteinerungen des Harzebirges, pl. xii, fig. 23.

Specific Character.—Shell ovate, or imperfectly pentagonal, front margin straight, rounded, or slightly emarginated, valves almost equally and evenly convex, with or without a small depression near the front in the central valve, beak slightly produced and truncated by a small circular foramen: beak-ridges more or less defined. Surface smooth. Proportions variable. Two British specimens have measured

Length 10, width 8, depth 5 lines.

„ 6, „ 6, „ 3½ „

Observations.—While describing the Terebratulæ from the Middle Devonian Limestone of Barton and Lummaton, near Torquay (*T. juvenis* excepted), Professor Phillips appears to have laboured under the same difficulties and uncertainties I now experience in the identification of these very variable shells. These Barton Terebratulæ are divided by Phillips into three so-termed species; those that are oblong-ovate with a straight or emarginated front he identifies with *T. sacculus*; those that are ovato-lanceolate, uniformly convex, with a prominent beak, and contracted nearly straight front margin, he terms *T. virgo*; while others are believed by him to resemble young specimens of *T. hastata* from the Mountain-limestone. It would not, however, be correct to admit three distinct species out of so variable a shell, and especially so, when in a handful of specimens every gradation of shape can be found connecting the three extreme conditions described by Phillips. At p. 214 of my Carboniferous Monograph, I entered into many details in

order to show the apparently very close connection existing between all our hitherto discovered British Carboniferous and Permian Terebratulæ, and which are in all probability mere variations in shape of a single species, and it is my impression that the Devonian form above described is nothing more than another slight modification of the Carboniferous species, or, in other words, that both the Carboniferous and Permian shells are derived from, or are mere slight modifications of the Devonian one above described. Mr. Bouchard is, however, of opinion, that figs. 1 to 8 of our plate should be referred to Scholtheim's *Ter. elongata*, a form found in the Permian strata of England and of the Continent, as well as in the Devonian Limestone of Grund in the Hartz; at Ferques, near Boulogne, and in that of the Eifel, I am quite ready to admit with Mr. Bouchard, that some of our Barton and Lummaton specimens do exactly resemble young examples of *T. elongata*, which have both valves convex, and a nearly straight front line; but it must also be remembered that in adult and well-shaped specimens of Scholtheim's species the ventral valve presents in profile a regularly arched curve from the extremity of the beak to the front, with a wide depression or shallow sinus, commencing towards the middle of the valve and extending to the front, producing in the frontal margin a convex and elevated curve, varying in degree according to age and individual, but which is not the usual aspect of Barton and Lummaton species. It appears to me probable that the shell under description will be more correctly located with *T. sacculus*, and of which *T. hastata* and *T. Gillingensis* are varieties, for many of our Lummaton specimens exactly resemble each of these modifications, and which we consider to belong to a single species. I should also mention that Mr. Carrington has recently discovered several examples of *T. sacculus* with colour-bands similar to those we have described in *T. hastata*, so that one of the objections brought forward by some palæontologists to the uniting of those two so-termed species is now removed.

It is quite evident that Scholtheim originally applied the name of *T. elongata* to the Permian form, but that subsequently he referred some Devonian specimens to his Permian type, and I have shown in Pl. 54, figs. 1—4 of my Carboniferous Monograph, that many specimens of the Carboniferous *T. hastata* and the Permian *T. elongata* are undistinguishable.

From these considerations I quite coincide in the opinion expressed by Mr. Bouchard, that it would be only encumbering science with another useless synonym were we to give to the Devonian form a separate specific designation, and as that of *Sacculus* is the oldest on record, it would I think be prudent to make use of it in the present instance. *T. sacculus* has been also found in the Middle Devonian Limestone of the neighbourhood of Plymouth, and in the Upper Devonian (?) brown grits of Ilton and Marwood in Devonshire.

? *TEREBRATULA ELONGATA*, *Schlotheim*. Pl. I, fig. 9.

TEREBRATULITES ELONGATUS, *Schloth.* Akad. Münch., vol. vi, pl. vii; figs. 7—14, 1816;
and Nachträgen zur Petrefactenkunde, pl. xx, fig. 2,
1822.

Some internal casts of a *Terebratula*, resembling specimens of *T. elongata*, from our British Permian shell-limestone, have been found in brown grits of the Upper Devonian (?) (Pilton and Marwood series) of East Hill, Braunton, North Devon.

TEREBRATULA JUVENIS, *Sow.* Pl. I, figs. 10—15.

ATRYPA JUVENIS, *Sow.* Geol. Trans., 2d ser., vol. v, pl. 56, fig. 8.

TEREBRATULA JUVENIS, *Phillips*. Figures and Descript. of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 90, pl. xxxv, fig. 165, 1841.

Spec. Char. Shell ovate, as broad as, or longer than wide, contracted in front, widest near the beak. Ventral valve deep and uniformly convex; beak wide, rounded, and much incurved; foramen minute, contiguous to the umbone; lateral ridges angular; forming well-marked curves on either side. Dorsal valve nearly flat, or slightly convex, sometimes rather depressed in the middle and at the front; surface smooth, marked only by lines of growth. Proportions variable.

Length 7, width 6, depth 4 lines.

„ 5, „ 5, „ 3 „

„ 5, „ 5½, „ 3 „

Obs. This *Terebratula* is remarkable on account of the great difference observable in the respective convexity of its valves; the dorsal one being perfectly flat in young examples, and but slightly convex even in adult individuals, whilst at all ages the ventral valve is deep and very convex. The shell is also characterised by a peculiarly shaped beak, which looks as if it had been compressed so as to touch and overlie the umbone, which leaves a flattened space between its angular beak-ridges and the hinge-line. The interior is unknown, but the loop was in all probability short and simple.

T. juvenis abounds in the limestone of the Middle Devonian of Barton and Lummaton, near Torquay. The original type described by Sowerby was derived from similar beds near Plymouth, and is now preserved in the museum of the Geological Society of London.

TEREBRATULA? *NEWTONIENSIS*, *Dav.* Pl. I, figs. 16, 17.

Spec. Char. Shell slightly pentagonal, valves almost equally deep, and moderately convex, depressed or flattened along the middle near the front; beak not very prominent,

with well-marked lateral ridges in either valve, continued along the sides without incurving to join the hinge and lateral margins, and leaving a concave, subparallel space between them and the hinge-line; foramen minute, completed by a deltidium; surface smooth. Dimensions variable; length 12, width 13, depth 5 lines.

Obs. Of this species I have seen three or four examples derived from the Middle Devonian limestone of Lane's or Woolborough quarry, near Newton Abbot, in Devonshire;¹ but, from not having been able to examine its internal dispositions, I am uncertain as to its genus, and have, therefore, provisionally located it under *Terebratula*. In external shape, *T. Newtoniensis* bears much resemblance to the Jurassic *Waldheimia numismalis*; but it might perhaps belong to Prof. Suess's sub-genus *Meganteris*. The thickening or emargination of the valves is very great in some specimens, reminding us of what is sometimes seen in *Terebratula carinata*. One large example in the collection of Mr. Vicary came to hand too late to be figured in its proper place.

T. Newtoniensis occurs also in the Devonian limestone of Néhou in France, from whence I obtained two examples.

¹ Mr. Pengelly informs me that there are various limestone-quarries, all more or less good fossil-localities, in the neighbourhood of Newton Abbot (Newton really consists of two towns, Newton Abbot and Newton Bushell, separated by a small stream), namely, Woolborough, Ramsleigh, Ogwell (2 or 3), Bradley (2), and all spoken of by strangers, and even by resident collectors, under the common term "Newton;" it is therefore desirable, where possible, to mention the exact locality, as some species occur in one place which are not found in the others. The same may be said with reference to Torquay and its neighbouring localities, Barton, Lummaton, Hope's Nose, Meadfoot, &c. Barton and Lummaton quarries are among the richest spots we are acquainted with, and are situated at about two miles' distance from Torquay. The village of Barton lies between them; Phillips, and all other strangers, would in all probability call both "Barton." The Lummaton quarry is at the north-west extremity of the mass of limestone which forms a great part of the Torquay peninsula. Barton quarry is in an outlier of the same, and is separated from it, perhaps, about three furlongs, the intermediate vale being occupied by the Devonian slate, which underlies the limestone. I have no doubt, from the similarity of many of the fossils, that both Barton and Lummaton are on the horizon of the Woolborough beds. Hope is frequently mentioned by Phillips; it should be Hope's Nose, the northern extremity of Torbay. This is again a limestone outlier, a relic which, like sundry islets in Torbay, testifies to a vast amount of denudation; the strata are well marked, but greatly contorted and cleaved, and occasionally unconformable, so that the fossils are but rarely well preserved. The Woolborough limestone is a very curious deposit; some parts of it have a very metamorphosed aspect, and very frequently the change is so very sudden that small hand-specimens appear like parts of different rocks. Occasionally, moreover, the quarrymen suddenly break into small cavities containing an almost black, unctuous powder, in which our best fossils occur. This powder contains a considerable amount of iron. Many of the limestones contain siliceous. This quarry is mentioned by the late Sir H. De La Beche, under the name of "Newton Quarry," as remarkable for the number and variety of the fossils it has yielded, Mr. Godwin-Austen having found no fewer than 139 species (see 'Memoirs Geol. Survey,' vol. i, p. 88). Ramsleigh is about half a mile from Woolborough, and belongs to the great mass of Ogwell, Ipplepen, and Denbury limestones. There are also several distinct localities in the neighbourhood of Plymouth, &c., which should be carefully noted.

Sub-genus—RENSSELÆRIA, Hall.

RENSSELÆRIA STRINGICEPS,¹ var.? *F. Roemer* (sp.). Pl. IV, figs. 5, 6, 7.

TEREBRATULA	STRIGICEPS,	<i>F. Roemer.</i>	Rhein. Uebergangsgeb., p. 58, tab. i, fig. 6, 1844.
—	—	<i>Ibid.</i>	<i>Schnur</i> , in Dunker und Von Meyer's Palæontographica, vol. iii, p. 183, tab. xxv, fig. 2, 1853.
RHYNCHONELLA	—	<i>Sandberger.</i>	Die Brachiopoden des Rheinischen Schichten-Systems in Nassau, p. 41, pl. xxxii, fig. 14, 1855.

Spec. Char. Shell oval, elongated; valves almost equally convex, without fold or sinus; beak much incurved and pointed; surface of valves covered with numerous small radiating ribs, which increase in number by the intercalation of additional ones at various distances from the beak. Proportions variable; length 12, width 9 lines.

Obs. Of this interesting species I can offer but an incomplete description, on account of the very imperfect material at command, consisting of casts and impressions, chiefly of the ventral valve, discovered by Mr. Valpy in the Middle (?) Devonian limestone of Hagginton Hill, near Ilfracombe. Having compared these casts with others of *T. stringiceps* from the Eifel, I could discern no valid ground for the creation of a separate species, and will, therefore, at any rate provisionally leave our British specimens under the specific name of *stringiceps*. I am also somewhat uncertain as to the genus to which these casts should be referred; but cannot, I think, be very far mistaken while provisionally leaving them with *Rensselæria*, a sub-genus proposed by Professor Hall for a set of shells, such as *R. Suessana* and *R. ovoïdes*, and which appear to nearly agree in general character with *R. stringiceps*. Professor Hall describes his sub-genus as follows:—"Shell inequivalved, oval, ovoid or suborbicular, elongated or rarely transverse, generally gibbous or ventricose; valves more or less convex, without mesial fold or sinus; beak prominent, acute, more or less incurved; foramen terminal, sometimes concealed; . . . surface radiatingly striated, or finely plicated, rarely smooth;"² all which would agree with the description we have given of the exterior characters of *R. stringiceps*. The muscular impressions resemble those observable in *Rensselæria*, but nothing further can be said relative to the interior dispositions, although we have reason to suspect that they must be similar to those described by the American palæontologist, and which consist of an elongated loop not unlike that so well described by Professor Suess in *Meganteris*, to which the sub-genus *Rensselæria*, if not a synonym, is at any rate very nearly related.

R. stringiceps has been obtained from the Lower Devonian beds of the Rhine, in Nassau, &c.

¹ Roemer spells this name *Strigiceps*, but it ought by right to be *Stringiceps*, in accordance with the Greek genitive, as *Stringocephalus*.

² 'Twelfth Annual Report of the Regents of the University of the State of New York,' p. 38, 1859.

Genus—STRINGOCEPHALUS, *Defrance*.

STRINGOCEPHALUS BURTINI, *Defrance*. Pl. I, figs. 18—22; Pl. II, figs. 1—11.

- STRIGOCEPHALUS BURTINI, *Defrance*. Dic. des Sciences Naturelles, vol. li, p. 102, et Atlas, pl. lxxv, figs. 1, 1^a, 1827.
- TEREBRATULA PORRECTA, *Sow.* Min. Con., pl. 576, fig. 1, Nov., 1827.
- STRIGOCEPHALUS BURTINI, *Blainville*. Malacologie et Conchyliologie, p. 511, t. liii.
- TEREBRATULA STRIGOCEPHALUS, *V. Buch.* Ueber Terebrateln, p. 117, 1834.
- STRIGOCEPHALUS GIGANTEUS, *Sowerby* (*Terebratula gigantea*, *Sow.*, Encyc. Metrop.), Trans. Geol. Soc. of London, vol. v, 2nd series, pl. lvi, figs. 10, 11, 1837-39.
- STRIGOCEPHALUS BURTINI, *D'Archiac et De Verneuil*. Description of the Fossils in the Older Deposits of the Rhenish Provinces; Trans. Geol. Soc. of London, 2nd series, vol. vi, p. 393, 1840.
- DORSATUS, *De Vern.* (*Strygocephalus dorsalis*, *Goldf.*, Bonn Mus.). Ibid., p. 369, pl. xxxv, fig. 5, 1840.
- STRIGOCEPHALUS BURTINI, *Phillips*. Figs. and Descrip. of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 79, fig. 141, 1841.
- GIGANTEUS. Ibid., p. 80, fig. 142.
- STRINGOCEPHALUS BURTINI, *F. A. Roemer*. Beiträge zur Kenntniss des Nordwestlichen Harzgebirges in Dunker u. V. Meyer's Palæontographica, vol. iii, p. 24, pl. x, fig. 2, 1850.
- UNCITES LÆVIS, *M'Coy*. British Palæozoic Fossils, p. 380, pl. ii A, fig. 6, 1852.
- STRINGOCEPHALUS BURTINI, *Schnur*. Beschreibung Eifel. Brachiopoden, p. 195, pl. xxviii, fig. 5; pl. xxix, fig. 1; pl. xxxi, fig. 1, 1853.
- — *Davidson*. Introduction, p. 73, pl. vii, fig. 98, and French Ed., Mém. de la Soc. Linnéenne de Normandie, vol. x, p. 74, figs. 45—50, 1856.
- — *Suess*. Zur Kenntniss *Stringocephalus Burtini*, Verhandl. d. z. b. Vereins, iii, 1853, and German Ed. of Davidson's Introduction, pl. i, fig. 16, 1856.
- — *Hians, Sandberger*. Die Brachiopoden Rheinischen Schichtensystems in Nassau, p. 31, fig. 4, 1855.

Spec. Char. Shell very variable in shape, suborbicular, transversely or longitudinally oval; valves usually either evenly convex, without fold or sinus, or with, sometimes, a more or less distinct median groove upon each valve. Ventral valve usually somewhat deeper than the ventral one; beak incurved, more or less prominent, entire and pointed at its extremity; hinge-area distinct, and in the young age divided by a large fissure, which becomes with age gradually surrounded by the deltidium, so as to become oval, and even sometimes finally closed, in some adult individuals. External surface smooth, and, when perfectly preserved, covered with very fine, delicate, slightly undulated, longitudinal striæ. Valves articulating by means of a large prominent tooth situated on either

side at the base of the deltidium, close to the hinge-line, and fitting into corresponding sockets in the smaller valve. In the interior of the ventral valve a large, mesial, longitudinal septum extends from the extremity of the beak to within a short distance of the frontal margin. This plate is thick at its origin and base, but gradually decreases in width while increasing in depth as it recedes from near the extremity of the beak. In the smaller or dorsal valve a massive, curved, very prominent cardinal process stretches to the opposite valve, where it clasps the ventral mesial septum with its forked extremity. Near the base of this process in the dorsal valve a longitudinal septum arises, smaller than that of the ventral valve, and divides the quadruple impression of the adductor-muscle; the socket-walls are very much expanded, forming prominent hinge-plates curving inwards on each side of the cardinal process. The lower portion of the hinge-plate supports a shelly loop in the shape of two flattened stems or lamellæ, which, after proceeding with a slight upward curve to near the extremity of the septum, are suddenly reflected, and again approach the sockets before sweeping submarginally round in the shape of a large, wide loop, from the inner edge of which a number of smaller lamellæ branch off and converge. Shell-structure punctate. Dimensions variable; some examples have attained five or six inches in length by something less in width, but the generality of specimens have smaller proportions.

Obs. This very interesting and characteristic Devonian species has been the subject of much investigation; and although its internal arrangements were partially known since many years, it is to Professors King and Suess that science is mainly indebted for the knowledge we now possess of the calcified supports of the labial appendages. Like many of its congeners, it has been shifted about from genus to genus, and has received several specific denominations; but palæontologists have now very generally agreed to retain for it the generic and single specific denomination *Stringocephalus*¹ *Burtini*.

Professor Suess, in his excellent paper, 'Zur Kenntniss des *Stringocephalus Burtini*,' states that, if one discards the very doubtful figure in Schlotheim's 'Petrifactenkunde' (p. 260, pl. xvi, fig. 4), it is Defrance who was the first to name and describe the species. In the month of November of the same year Sowerby published a description and figure of the same shell from Bradley, under the name of *Terebratula porrecta*.

To varieties also of this species Hoeninghaus and Goldfuss have given two catalogue-names, *Strig. elongatus* and *Strig. striatus*; and in the 'Encyclopædia Metropolitana' Sowerby described and figured some large, flattened, and distorted examples of *String. Burtini* from Plymouth, under the denomination of *Terebratula gigantea* and *T. Hennahiana* (see likewise 'Geol. Soc. Trans.,' 2 ser., vol. v, part 3, Explan. of plates).

¹ The etymology of Defrance's term *Strygocephalus* has been the theme of some difference in opinion. Dr. Sandberger appears to have been the first palæontologist who wrote the name *Stringocephalus* (in Leonhard und Bronn's 'Jahrb.,' 1842). The term *strix*, sometimes from corruption written *stryx* or *strux*, means a screech-owl (στυξ, genitive στυγγος, *stringos*), and is no doubt the meaning intended by Defrance, although he spelt the name erroneously.

Strig. dorsalis, D'Archiac and De Verneuil, is a variety having a more or less distinct median groove upon each valve, this groove being prolonged to the beak of the ventral valve and only to about the middle of the dorsal one. It is, however, a mistake to suppose that it is only this variety which has its surface covered with delicate, longitudinal striæ, for I have observed the same on some well-preserved German specimens which had no groove in either valve.

Stringocephalus Burtini has assumed many shapes and degrees in the projection and incurvature of its beak, and Professors De Koninck and Suess, who have along with myself examined the original example of M'Coy's *Uncites lævis* (Pl. II, fig. 9, of this monograph), have expressed it to be their opinion that the last-named shell is nothing more than an exceptional, much elongated example of DeFrance's *String. Burtini*.

Stringocephalus Burtini is a characteristic fossil of the Middle Devonian limestone or "Stringocephalen-Kalk" of the Germans. In England it occurs in South Devonshire at Plymouth; Bradley, near Newton; and Chircombe Bridge, near Oggwell. In North Devon at Combe Martin and Hagginton. Mr. Valpy states that he found a specimen in the limestone of Ilfracombe.

On the Continent it is very abundant at Paffrath, near Cologne, at Villmar, and in the Eifel; also at Diete, Brilon-upon-the-Lahr, and at Chimay and Nimes in Belgium, &c.

Family—SPIRIFERIDÆ.

Genus—ATHYRIS, M'Coy,¹ vel SPIRIGERA, D'Orb.

¹ In 1853, while publishing my 'General Introduction' in the first volume of the present work, I proposed to apply the term *Athyris*, M'Coy, to shells such as *Atrypa tumida*, Dal., and *Terebratula Herculea*, Bar., and to make use of D'Orbigny's better name *Spirigera* for those species with a perforated beak, such as *Athyris concentrica*. This view or substitution of names and shells was subsequently objected to, it being justly considered that as M'Coy's generic designation of *Athyris* was intended for shells such as *A. concentrica*, that it could not be correctly applied to another group of species. Therefore, much to my regret, but in order to adhere to the law of priority, I subsequently restored to *Athyris A. concentrica* and its congeners, and made use of *Merista* for those to which I had, in 1853, applied the term *Athyris*. I believe, however, that with time the term *Athyris* will be completely disused, and that of *Spirigera* preferred, as the law of priority should not be allowed to perpetuate a palpable zoological misnomer. Mr. R. Jones is of opinion that *generic*, being *group* names, may be improved upon (see his 'Monograph on *Estheriæ*,' p. 11, note).

In the 'Thirteenth Annual Report of the Regents on the State Cabinet of New York,' published in 1860, Professor Hall makes some interesting observations on the subject, which we will transcribe, as being little known in this country.

"Among the fossils referred for many years to *Terebratula*, *Atrypa*, &c., European authors have separated the genera *Athyris* and *Merista*, shells which have many characters in common, and which were, indeed, at first united under *Spirigera* or *Athyris*, until in 1851 the genus *Merista* was proposed by Professor Suess. In my later studies of the Brachiopoda of the American Palæozoic strata, I have referred to the genus *Athyris* certain species which have a subglobose or ovoid form, with lamellose surfaces, and

ATHYRIS CONCENTRICA, *Von Buch* (sp.), 1839. Pl. III, figs. 11—15, and 24.

TEREBRATULA CONCENTRICA, *Von Buch*. Ueber Terebrateln, p. 103, Berlin, 1834; and
Mém. Soc. Géol. France, vol. iii, p. 214, 1839 (described,
but not figured).

without or with scarcely perceptible radiating striæ; while other forms, which are less distinctly lamellose, and always more or less distinctly radiatingly striate, with fine concentric lines of growth, I have referred to the genus *Merista*. Many of the latter have the general form and surface-characters of *Merista* (*Atrypa*) *tumida*, Dalman, but are less ventricose; they all have internal spires, and, when perfect, the beaks appear to be imperforate. The radiating striæ, though visible in well-preserved specimens, are still more conspicuous in the partially exfoliated shell. *Atrypa tumida* of Dalman is cited by Davidson as one of the types of the genus *Merista*.

"I proposed last year ('Twelfth Report of the Regents') a separation of certain *Merista*-like forms under the name of *Camarium*, on account of the presence of an arching transverse septum in the ventral valve. Subsequently a more careful consideration of the characters of *Merista*, as given by Mr. Davidson, and an inspection of his figures, have shown me that the arching septum, in its attenuation towards the beak, is identical with the shoelifter process described as belonging to the genus *Merista*. An examination of numerous specimens of different species of those which I have referred to the genus *Merista* shows no evidence of this process or septum, and the deep muscular impression below the rostral cavity, and the thickening of this part of the shell, are characters incompatible with the existence of the septum. Moreover, I conceive that this arching septum, or the extension of the shoelifter process into the cavity of the valve, would produce such a modification of the soft parts of the animal, that the inhabitants of these shells were generically distinct from the inhabitants of the large uninterrupted cavity of the shells which heretofore I have referred to *Merista*.

"In order, if possible, to reach a solution of the question, I have had the shell removed from a solid specimen of *M. tumida* (from Dudley), which is one of the types of the genus, and there is certainly no evidence of the septum or shoelifter process, but, on the contrary, the presence of all the character-markings of the American species which I have referred to *Merista*, in vol. iii, 'Pal. New York.' At the same time, the *Merista* (*Terebratula*) *scalprum* of Barrande [*Herculea* of Barrande, or *scalprum* of Roemer], in the most solid of the specimens which I possess, really reveals the presence of the septum.

"Since this shoelifter process, or septum, was originally described by Professor Suess as characteristic of the genus *Merista*, and the species designated by him as the types of the genus (the *M. scalprum* and *M. Herculea* of Barrande) 'do possess this feature, the genus must be retained for the species with the shoelifter process.' (Davidson.)

"It would appear, therefore, that the genus *Camarium*, proposed by me in the preceding report, possesses characters identical with *Merista*, as originally described by Suess, but which have been overlooked to some extent in consequence of the reference to *M. tumida* as a typical form of the genus At the same time, as the *M. tumida* of Dalman, an English and Swedish species, in common with numerous well-marked forms in our Silurian and Devonian strata, do not possess this feature, we can no longer with propriety refer them to that genus.

"With this restriction, the *Meristæ* proper consist of smooth, ovoid, circular, or transverse shells, with usually a conspicuous sinus upon the ventral valve, and a corresponding wide, often undefined, mesial fold or elevation upon the dorsal valve; the hinge-articulation being not very different from that of *Athyris*, to which they are allied.

"The interior of the ventral valve, however, is strongly distinctive, and the septum or shoelifter process

- TEREBRATULA HISPIDA, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. liv, fig. 4.
 — CONCENTRICA, *De Verneuil.* Bull. Soc. Géol. de France, vol. xi, p. 251,
 pl. ii, fig. 1, 1840.
 SPIRIGERA CONCENTRICA, *D'Orb.* Prod., vol. i, p. 98, 1849.
 ATHYRIS CONCENTRICA, *M'Coy.* British Palæozoic Fossils, p. 378, 1852.
 SPIRIGERA — *Dav.* General Introduction, vol. i, pl. vi, figs. 65—67, 1853.
 TEREBRATULA — *Schnur.* Beschreibung Eifel. Brachiopoden, in Palæontographica,
 vol. iii, p. 3, 1853.
 ATHYRIS — *Morris.* A Catalogue of British Fossils, p. 130, 1854.
 SPIRIGERA — *Sandberger.* Die Brachiopoden Rheinischen Schichten-Systems in
 Nassau, p. 31, pl. xxxii, fig. 11, 1835.

Spec. Char. Shell usually wider than long, suborbicular, transversely oval, circular, or slightly subpentagonal, with rounded contour; valves almost equally convex, increasing in gibbosity with age. When young, the front is evenly rounded, but with age a more or less developed broad lobe or mesial fold commences at a little further down than the middle of the valve, and extends to the front, near to which it attains its greatest elevation. In the ventral valve a sharply defined sinus commences towards the middle of the valve and extends to the front. Beak tumid, moderately produced, incurved and truncated by a small circular aperture lying close to the umbone of the opposite valve; beak-ridges undefined, surface more or less deeply marked by numerous close, concentric, regular, imbricating laminæ of growth. In the interior of the smaller or dorsal valve the hinge-plate presents four depressions or pits, and close to the extremity of the umbo a small circular aperture appears to communicate with a circular tube, which, after originating under the platform, extends longitudinally and freely with a slight upward curve to about

is not unfrequently shown in the cleavage of the beak of that valve, in solid specimens, where the interior is inaccessible.

"The forms which I have regarded as *Merista* are similar to those above; but instead of this septum, or shoelifter process, they have a deeply marked, triangular, muscular area, just below the rostral cavity of the ventral valve, which is bordered on the anterior side by a callosity of the shell, and on the two other sides by the strong dental lamellæ. This feature is not conspicuous in *Athyris*; the dental lamellæ in that genus are shorter and less strong, and the form of the muscular impression is different. The dorsal valve of those shells now under consideration has a longitudinal median septum, a feature which is obsolete, or partially obsolete, in the species of *Athyris*. In the *Camarium* or *Merista* proper the exterior of the ventral valve sometimes shows what appear to be two diverging septa, somewhat similar to those in the dorsal valve of *Pentamerus*, which are the margins of the shoelifter process

"Restricting, therefore, the signification of the genus *Merista* to such forms as were originally included by Professor Suess under that name, it becomes necessary to designate those species of similar form, but without the peculiar appendage of the ventral valve, by another generic term, and I would therefore suggest the name *Meristella*, proposed by me last year." These three genera or sub-genera would therefore be typified as follows:

1. ATHYRIS, or SPIRIGERA. Ex. *A. concentrica*, *A. phalæna*, &c.
2. MERISTA. Ex. *M. Herculea*, *M. plebeia* = *M. scalprum*, &c.
3. MERISTELLA. Ex. *M. tumida*, *M. lævis*, *M. bella*, &c.

a third of the length of the valve. To the inner extremities of the socket-ridges are fixed the spinal processes, with their extremities directed towards the lateral margins of the shell. The spiral cones are united by a complicated system of lamellæ, somewhat as in *A. pectinifera*, *A. Royssii*, &c. No defined septum is observable in this valve, but a rudimentary mesial ridge divides the quadruple impressions of the adductor. In the ventral valve the dental plates are tolerably developed, while the adductor leaves a small oval scar towards the middle of the valve, and which scar is separated into two parts by a minute mesial elevation, under and outside of which are seen the large impressions of the divaricator muscle. Proportions variable; the largest English specimen I have seen measured—length 13, width 15, depth 8 lines.

Obs. This species is characteristic of the Upper Devonian strata of France, as well as of other countries, but does not appear to be very common in Great Britain, if I may so judge from the very scanty and imperfect material I have been able to assemble.

In Devonshire a few adult but incomplete examples have been found by Mr. Pengelly in shales at Mudstone Bay. Internal casts showing the muscular impressions have been met with by Mr. M. Hall in brown grits of the Marwood and Pilton Upper Devonian (?) series at Orchard quarry, Pilton, one mile north of Barnstaple, and large impressions of the same shell were found by the same gentleman at Croyde Bay, seven miles west-north-west of Barnstaple.

A. concentrica has been met with at Hope's Nose, near Torquay, and in dark-gray slate at Galmpton Creek, on the River Dart, but usually in a very fragmentary and contorted condition; and it has also been obtained from the Upper Devonian strata of South Petherwin, in Cornwall. At page 130 of his 'Catalogue,' Professor Morris mentions that the shell occurs in the Middle Devonian of Newton and Ogwell, in Devonshire; but from those places I have not seen specimens.

On the Continent it is a common fossil at Ferques and Néhou, in France; at Refrath and Gladbach, in the Eifel; at Hübigenstein, Tchudovo, &c.; but I am not quite certain whether it has been really discovered in America, notwithstanding that the *Athyris* (*Terebratula*) *spiriferoides*, Eaton, has been referred to *A. concentrica* (but with uncertainty), by M. De Verneuil, Conrad ('Ann. Rep. New York,' pl. iii., 1832), and others. In his 'Final Report, 4th District, New York,' p. 198, fig. 5, Professor Hall expresses a similar opinion to that advocated by M. De Verneuil; but subsequently, in the 'Report of the Regents of the University,' p. 113, 1857, he observes that "this species (the *Spirifera spiriferoides*) has generally been referred to the *Terebratula* (*Spirigera*) *concentrica* of Bronn, from which it differs in the straightness of its hinge and much less prominent beak. It also presents other slight but constant differences of form, the broadest part being almost always a little above the middle, while in *T. concentrica* it is generally a little below it (?). The lamellæ are likewise more distinctly imbricated in our shell than in *Sp. concentrica*. A comparison of the European specimen with the American ones has shown the propriety of separating them, and of adopting the name given by Eaton in 'Silliman's Journal,' 1831."

Athyris hispida, Sow. (fig. 24), has been considered by Professors M'Coy and Morris to belong to *A. concentrica*; but not having been able to see the original example, I can hardly express a decided opinion upon the subject.

M. Bouchard is of opinion that figs. 11 and 12 of our plate should be considered a different, but closely related, species; but I have not ventured to separate them from *A. concentrica*, to which they appear to me connected by numerous gradations in shape; indeed, in a large series of specimens of *A. concentrica* from the Eifel, now before me, some young and old examples appear almost smooth, so fine are the concentric lines and laminae, while in other specimens of the same dimensions these same lines and laminae are strongly marked and developed.

Professors M'Coy and De Koninck have considered *Atrypa decussata* and *A. indentata* (Sowerby) as synonyms of the species under description; but, as I have not been able to examine the original examples so named, nor any other specimens of these so termed species, I shall express no positive opinion upon the subject, and content myself by reproducing the author's original description and figures.

(*Athyris*?) *Atrypa decussata*, Sow. Plate III, fig. 17. (Sowerby, 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liv, fig. 5.)

"Subglobose, slightly compressed; front even, straight; surface concentrically striated and decussated; beak of the lower valve very little prominent, with a trifling angle on each side. *Loc.*, Petherwin."

(*Athyris*?) *Atrypa indentata*, Sow. Plate III, fig. 16. (Sowerby, 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liv, fig. 6.)

"Transversely obovate, with an indented front; the edge of the lower valve elevated, its beak small, prominent.

"The front of this shell appears as if impressed by the finger, whence its name. The elevation in the margin of the lower valve does not affect the surface of the other. This may serve to distinguish it from *A. obovata* ('Silur. Syst.,' pl. viii, fig. 9), to which it bears a very close affinity.

"*Loc.*, Petherwin (with the last, abundant), Barnstaple."

(*Athyris*?) *Atrypa oblonga*, Sow. Plate III, fig. 1. (Sowerby, 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liii, fig. 6.)

"Oblong-oval, convex, smooth; front produced, elevated; the elevation narrow. *Loc.*, Barnstaple."

It is stated by Professor M'Coy, p. 378 of his 'British Pal. Fossils,' that this is a crushed internal cast of *A. concentrica*; but, although I have seen the original specimen in the Geological Society's Museum, I would not, upon such scanty and unsatisfactory material, either venture to confirm or infirm the statement given by the distinguished palæontologist above named.

ATHYRIS PHALÆNA, *Phil.* (sp.), 1841. Pl. III, figs. 19, 20, 21.

SPIRIFERA PHALÆNA, *Phillips*. Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 71, pl. xxviii, fig. 123, 1841.

— HIRUNDO, *Phillips?* Ibid., pl. xxviii, fig. 122.

TEREBRATULA HISPANICA, *De Verneuil*. Bull. Soc. Géol. France, 2nd ser., vol. ii, p. 463, pl. xiv, figs. 6, 7, 1845.

SPIRIGERA PHALÆNA, *Dav.* General Introduction, British Foss. Brach., vol. i, pl. vi, fig. 70, 1853.

Spec. Char. Transversely elongated, two or three times wider than long, with rounded cardinal angles. Hinge-line slightly curved, valves moderately convex, with a wide biciplicated fold in the dorsal valve, and wide sinus in the ventral one, bordered by two rounded ribs; beak small, incurved and truncated by a small circular aperture; beak-ridges tolerably defined, leaving a somewhat elongated flattened space between them and the hinge-line. External surface regularly traversed by continuous, equidistant, small ridges or furrows. Dimensions variable, the only two British examples hitherto discovered measured—

Length 7, width 16 lines.

„ 5, „ 17 „

Obs. This very interesting species appears to be rare in great Britain, for I have been able to examine but two imperfect specimens, obtained by Professor Phillips at Hope's Nose, near Torquay, and now preserved in the Museum of the Geological Survey of Great Britain; and indeed but one of these two (a single imperfect ventral valve) was named *Sp. phalæna* by Phillips, while the second decorticated example received the name of *Sp. hirundo*. Both are, however, considered by Professor De Koninck and myself as belonging to a single species. *Sp. phalæna* occurs plentifully in the Devonian limestone of Ferrones (Asturias), Spain, from whence M. De Verneuil obtained some examples which had attained one inch in length by three and a quarter in width. Some short time afterwards I discovered specimens of the same, but of smaller dimensions, in beds of the same age ("Rhenane"), at Néhou, in France.

ATHYRIS? BARTONIENSIS (n. sp.). Pl. III, fig. 23.

Spec. Char. Rhombic, with rounded angles, wider than long. Valves moderately and uniformly convex to about half their length, the remaining portion of the dorsal valve being trilobed, a concave space separating the central from the lateral lobes. A shallow sinus exists towards the front in the ventral valve; beak not much produced. External surface smooth, marked only by lines of growth.

Length $2\frac{1}{2}$ inches, width 3 inches, depth 1 inch 2 lines.

Obs. Of this remarkable species I have seen but one example, discovered by Mr. Lee, in the Middle Devonian limestone of Barton, near Torquay. It is not quite perfect, but by its dimensions and shape is so different from any other Devonian *Athyris*? with which I am acquainted, that I have ventured to give it a separate designation.

ATHYRIS? (n. sp.?). Pl. IV, fig 4.

We find in the Lower (?) Devonian grits of Looe, in Cornwall, distorted internal casts of a remarkably shaped shell, which we suppose to belong to the genus *Athyris*, but they are too imperfect to admit of specific determination. In shape the shell is somewhat transversely pentagonal, about one inch one line in length, by two inches two lines in width; the valves are moderately convex, with a shallow sinus in the ventral one; the beak is moderately produced, and there appears to exist a flattened space between its ridges and the hinge-line. I cannot venture to propose a specific denomination on such incomplete material, but better specimens may perhaps turn up now that the attention of collectors will have been called to the subject. M. Bouchard thinks it might belong to *Spirifera curvata*, a common Eifel species; but the obtuse hinge-line appears to me more like that of an *Athyris* than of a *Spirifera*. I may however be mistaken in my appreciation of the matter.

? ATHYRIS NEWTONIENSIS (n. sp.). Pl. III, fig. 22.

Spec. Char. Shell transversely oval, wider than long, valves almost equally convex, without fold or sinus; beak moderately produced, and truncated by a foramen; beak-ridges sharply defined, leaving a flattened or concave space between them and the hinge-line. External surface smooth, marked only by concentric lines of growth.

Length 1 inch 9 lines, breadth 2 inches 4 lines, depth 1 inch.

Obs. This shell was discovered by Mr. Champernowne in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot, Devonshire.

Genus—MERISTA, *Suess*.

MERISTA PLEBEIA, *Sow.* (sp.), 1837. Pl. III, figs. 2—10.

ATRYPA PLEBEIA, *Sow.* Trans. Geol. Soc., 2 ser., vol. v, pl. lvi, figs. 12, 13.

— LACRYMA, *Sow.* Ibid., fig. 9.

TEREBRATULA SUBCURVATA, *Münster.* Beiträge, Heft 3, pl. 14, figs. 4, 5, 6.

SPIRIFERA PLEBEIA, *Phillips.* Pal. Fossils of Devon, Cornwall, &c., p. 70, pl. xxviii, fig. 121, 1841.

SPIRIGERA PLEBEIA, *D'Orbigny.* Prodrome, vol. i, p. 99, 1849.

TEREBRATULA SCALPRUM, *Roemer.* Das Rheinisch. Uebergangsgeb., p. 68, pl. v, fig. 1, 1844.

Spec. Char. Shell transversely obovate, as wide as or a little wider than long; valves moderately convex, with a slightly elevated wide mesial lobe or fold, apparent only near the front of the dorsal valve; a shallow sinus or depression is visible in the corresponding portion of the ventral one; beak small, very much incurved; external surface marked with close contiguous lines of growth; proportions variable; two examples have measured—

Length 9, width 10, depth 5 lines.

„ 10, „ 9½, „ 6 „

Obs. This common species is very variable in shape, some specimens being wider than long, whilst others are longer than wide. It is usually almost circular, the mesial fold never attaining much projection or elevation. *Atrypa lacryma*, *Sow.*, of which the original type is preserved in the Museum of the Geological Society, along with the types of *A. plebeia*, appears to belong to the same species as the shell under description, for we find every intermediate shape uniting them. The generality of specimens have not their outer shell-surface perfect; and consequently a longitudinal line is seen to extend along the smaller or dorsal valve from the umbo to half or more of its length, denoting the presence of an interior septum, while two diverging lines extend from the extremity of the beak to about two thirds of the length of the valve, indicating the presence of large condyle-plates, to which are fixed the transverse plates, or shoelifter-shaped process, while in some examples the portion of the matrix between the hinge-plates has dropped out, leaving a triangular hollow in the shell or cast, as seen in fig. 5.

M. plebeia occurs abundantly in the Middle Devonian limestone of Mount Wise and Stonehouse Hill, near Plymouth; at Barton and Lunnaton, near Torquay; Ramsleigh Quarry, near Ogwell; Woolborough, near Newton Abbot; and at Hagginton Hill, near Ilfracombe, in Devonshire. On the Continent it occurs at Gerolstein, in the Eifel; at Elbersreuth, &c.

Genus—RETZIA, *King*.

RETZIA FERITA, *Von Buch* (sp.), 1834. Pl. IV, figs. 8—10.

TEREBRATULA FERITA, *Von Buch*. Ueber Terebrateln, 1834, p. 76, pl. ii, fig. 37; *Mém. Soc. Géol. de France*, vol. iii, pl. xvii, fig. 4.

— — *Phillips*. Pal. Foss. of Devon, Cornwall, and West Somerset, p. 89, pl. xxxv, fig. 163, 1841.

— — *D'Archiac et De Verneuil*. Trans. Geol. Soc., 2nd ser., vol. vi, p. 368, pl. xxxv, fig. 3, 1841.

SPIRIGERINA FERITA, *D'Orb*. Prodrôme, vol. i, p. 100, 1849.

TEREBRATULA — *Quenstedt*. Handb. der Petrefactenkunde, p. 475, pl. xxxviii, figs. 13, 14, 1851.

— — *Schnur*, in *Dunk. u. Von Meyer's Palæontograph.*, vol. iii, p. 184, pl. xxv, fig. 4, 1853.

RETZIA FERITA, *Sandberger*. Die Brachiopoden des Rheinischen Schichtensystems in Nassau, p. 34, pl. xxxii, fig. 13, 1855.

Spec. Char. Shell somewhat sub-triangular or oval, longer than wide, the greatest width being situated about the middle of the shell, or towards the front. Valves moderately convex. Surface costated; in the dorsal valve there exist five, seven, or nine strong ribs, of which the central one is usually (although not always) the largest, while in the ventral valve there are four, six, or eight, with a deep median groove corresponding to the central rib of the opposite valve. The surface of the valves is likewise crossed by numerous fine contiguous concentric striæ, while the shell-structure is very finely punctured. Beak elongated, nearly straight, tapering, and truncated by a small circular foramen which is rendered complete, and is separated from the hinge-line by a long narrow deltidium, a flattened space or small triangular area existing between the beak-ridges and the short nearly straight hinge-line.

In the interior, the shelly spiral processes are directed outwards. Proportions variable in different specimens.

Length 6, breadth 5, depth 3 lines.

Obs. This elegant little species has been several times beautifully figured, and is characteristic of the Middle Devonian limestone of England, as well as of the Continent. It occurs at Barton and Lummaton, near Torquay; near Newton Abbot, and at Dock Yard, near Plymouth. On the Continent it has been found in the Eifel at Villmar, in Nassau, &c.

Genus—UNCITES, *Defrance*.

UNCITES GRYPHUS, *Schlotheim* (sp.). Pl. IV, figs. 11, 12.

TEREBRATULA, *Beuth.* Julæ et Montium Subterranea, &c., p. 134, No. 74, 1776.

TEREBRATULITES GRYPHUS, *Schlotheim.* Petrefactenkunde, pl. xix, fig. 1, 1822.

UNCITES GRYPHOIDES, *Defr.* 1. Fér. Bull., 1827, xii, 152.

UNCITES GRYPHOIDES, *Blainville.* Conchyliologie et Malacologie.

— GRYPHUS, *Bronn.* Lethæa Geogn., 1 Auf., pl. ii, fig. 6.

GYPIDIA GRYPHOIDES, *Goldfuss.* Von Dechen's Translation of Sir H. De La Beche's Manual, p. 527, 1832.

TEREBRATULA GRYPHUS, *V. Buch.* Ueber Terebrateln, p. 69, 1834, and Mém. Soc. Géol. France, vol. iii, p. 174, pl. xvi, fig. 18, 1838.

UNCITES GRYPHOIDES, *Quenstedt.* Handb. Petrefactenkunde, p. 459, pl. xxxvi, fig. 40, 1851.

— GRYPHUS, *Davidson.* British Fossil Brachiopoda, Introduction, vol. i, p. 89, pl. vii, figs. 79—86, 1853.

— — *Sandberger.* Die Brachiopoden Rheinischen Schichtensystems in Nassau, p. 38, pl. xxxi, fig. 5, 1855.

— — *Woodward.* A Manual of the Mollusca, p. 225.

Spec. Char. Shell elongated, oval; bi-convex valves nearly equally deep, with a long incurved beak, tapering at its extremity, hollow and truncated in young specimens by a small, oval, apical foramen; no true area, a large concave deltidium partly surrounds the aperture, and extends to near the cardinal edge. The umbo of the dorsal valve is considerably incurved, and partially concealed by the deltidium of the opposite valve. The sides of the beak as well as the lateral portions of the umbo become at times considerably deflected inwards, producing deep, lateral, elongated, concave depressions or pouches opening externally, but not communicating with the interior. Surface covered with numerous longitudinal radiating striæ, or flattened ribs, which bifurcate at variable distances from the beak and umbo. Valves articulating by the means of teeth and sockets. Shell impunctate. Dimensions variable.

Length 16, width 14, depth 9 lines.

Obs. The interior characters of this species have not been completely determined. Professor Beyrich discovered in one specimen internal spiral processes, directed outwards; but I have some misgivings as to these spirals having in reality belonged to the specimens in question, and should be glad to find Professor Beyrich's discovery confirmed by the evidence of other specimens. The shape and position of the muscular impressions remain likewise still unknown; and it must also be remarked that the singular lateral pouch-shaped depressions do not occur in all the specimens. The beak is rarely straight, being more often bent to one side or the other.

This remarkable shell has been long known as characteristic of a certain horizon of

the Devonian period ('Stringocephalen-Kalk' of the Germans), but had not been noticed as a British fossil until the month of April, 1863; when I had the good fortune to discover one or two small incomplete examples among some fossils sent me by Mr. Champernowne, which he had obtained from a quarry on his estate of Dartington, near Totness, in Devonshire. The upper beds of the Dartington band of limestone contain the *Uncites*; and it is found likewise a little lower down in a dolomite, which is partly decomposed, forming quite sandy masses. Along with the shell under description I recognize the following species;—*Spirifera nuda*, *Sp. octoplicata*, *Atrypa reticularis* and *A. aspera*, *Pentamerus brevirostris*, *Rhynchonella primipilaris*, and *R. implexa*, and one or two others not sufficiently perfect to warrant a correct specific determination being arrived at. A larger and perfectly characterized species of the shell under description has also been discovered by Mr. Vicary, in Lane's or Woolborough Quarry near Newton Abbot. The British examples of *Uncites* hitherto discovered are small, however, when compared with others which I have picked up in the neighbourhood of Paffrath, and at Klustein near Gladback, in the vicinity of Cologne, and which attained nearly two and a half inches in length. Von Buch states that it is small at Gerolstein; and I have it also from Nimes in Belgium. Dr. F. Sandberger gives an excellent figure of a specimen he found in the Devonian limestone of Nassau.

Genus—SPIRIFERA, Sowerby.

SPIRIFERA DISJUNCTA, Sow. Pl. V, figs. 1—12; Pl. VI, figs. 1—5.

SPIRIFERA DISJUNCTA, Sow. Trans. Geol. Soc., 2nd ser., vol. v, pl. liii, fig. 8; pl. liv, figs. 12, 13.

— CALCARATA, Sow. Ibid., pl. liii, fig. 7.

— EXTENSA, Sow. Ibid., pl. liv, fig. 11.

— GIGANTEA, Sow. Ibid., pl. lv, figs. 1—4,

— INORNATA, Sow. Ibid., pl. liii, fig. 9.

— PROTENSA, Phillips. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 69, pl. xxviii, fig. 119, 1841.

— CALCARATA et SP. DISJUNCTA, Phillips. Ibid., pl. xxix, figs. 128, 129.

— DISJUNCTA, Phillips. Ibid., pl. xxx, fig. 129.

— GIGANTEA, Phillips. Ibid., pl. xxx, fig. 130.

? — GRANDEVA, Phillips. Ibid., pl. xxx, fig. 131.

— DISTANS, Phillips (not Sow.). Ibid., pl. xxix, fig. 127.

— VERNEUILII, Murch. Bull. Soc. Géol. France, vol. xi, p. 252, pl. ii, fig. 3, 1840.

— ARCHIACI, Murch. Ibid., pl. ii, fig. 4.

— LONSDALEI, Murch. Ibid., fig. 2.

SPIRIFER DISJUNCTUS, De Verneuil. Geol. of Russia, vol. ii, p. 157, pl. iv, fig. 4, 1845.

- SPIRIFER ARCHIACI, *De Verneuil*. Geol. of Russia, vol. ii, p. 157, pl. iv, fig. 6, 1845.
 — MURCHISONIANUS, *De Kon.* De Vern. and Keys., Geol. Russia, vol. ii, pl. iv, fig. 1, 1845.
 — DISJUNCTUS, *Dav.* Quarterly Journal of Geol. Soc., vol. ix, p. 354, pl. xv, figs. 1—5, 1853.
 — VERNEUILII, *M'Coy*. British Pal. Fossils, p. 376, 1852.
 — DISJUNCTUS, *Murchison*. Siluria, 2nd edition, p. 299, fig. 4, 1859.
 — BARUMENSIS, *Sow. MS.* Salter, Journal Geol. Soc., vol. xix, p. 480.

Spec. Char. Shell variable in shape, transversely semicircular or subrhomboidal; hinge-line usually as long as the width of the shell, with the cardinal angles slightly rounded, or extended to a greater or smaller extent, in the shape of long, attenuated, contracted prolongations; valves convex, sometimes gibbous. In the dorsal valve the mesial fold is sharply defined, of moderate convexity and elevation; in the ventral valve the sinus is concave; beak produced and moderately incurved; area triangular, flat, or concave, and of greater or smaller dimensions; fissure partly arched over by a pseudo-deltidium in two pieces. The surface of each valve is ornamented by from forty to ninety small radiating ribs, with interspaces of almost equal width. The ribs are simple on the lateral portions of the shell, but increased in number to a small extent on the mesial fold and sinus, by means of intercalated ribs, which appear at variable distances from the beaks; the whole surface is crossed by numerous, fine, contiguous, concentric lines. Dimensions variable, some very large examples having attained as much as two or more inches in length, by three or three and a half inches in width; but the larger number possessed smaller proportions.

Obs. This very important Middle and Upper Devonian species has been described and illustrated under many denominations; but I quite concur with those palæontologists who have considered *Sp. calcarata*, *Sp. extensa*, *Sp. gigantea*, *Sp. inornata*, *Sp. Verneuilii*, *Sp. Lonsdalei*, *Sp. Archiaci*, and *Sp. Murchisoniana*, and one or two more, as mere synonyms or variations in shape of a single species. *Sp. protensa* was founded on a single decorticated and injured specimen of what I take to be a mere variation in shape of the shell under description. *Sp. grandæva* has been described from such very imperfect material that it is hardly safe to offer any opinion as to its specific value, further than to say that Phillips' figure looks very like a variation in shape of *Sp. disjuncta*, and that the author himself admits that it is "decidedly allied to *Sp. gigantea*, but with only half the number of lateral ribs." It must be borne in mind that *Sp. grandæva* is a small shell, while *Sp. gigantea* is a very large or fully grown condition of the species, and is consequently possessed of a larger number of ribs. The term *Sp. Barumensis* appears to be a local name given to a large variety of *Sp. disjuncta*, with an unusually developed area; but the area is also very large in some examples of *Sp. disjuncta* proper, and cannot, therefore, be made use of as a specific character. I quite coincide with the observations made by Professor M'Coy, that, "when the shell approaches its adult size, it becomes the

Sp. gigantea of Sowerby and Phillips, without the slightest change of character, so that many of the specimens at Petherwin and Tintagel could not be referred by a conscientious observer to the one species in preference to the other. The character supposed by Phillips to distinguish *Sp. gigantea* from *Sp. disjuncta*, viz., the mesial fold being 'indistinctly furrowed or nearly smooth,' is negatived by Mr. Sowerby's original figures, by his type-specimens, and the greater number of others which I have seen. Mr. Sowerby has himself suggested the possible identity of his *Sp. disjuncta* and *Sp. gigantea*; and De Koninck and De Verneuil suspected the possible union of the four so-called species here united. Cleavage and pressure have produced the most singular contortions in specimens of this and other species; some are completely flattened or greatly elongated, while others are made to assume much more than their natural width; some, again, are bent and twisted to the one or other side, and completely put out of shape.¹

When describing *Sp. calcarata*, Sowerby states that his shell (of which the characters are taken from a single internal cast) "approaches closely to *Sp. attenuata*, M.Č.; but distinguished by the sudden contraction of the sides and the very slight elevation of the front. Still we have some doubts of its being distinct from the many varieties of that species." This leads me to observe that I possess two or three specimens of *Sp. striata*, var. *attenuata*, with simple lateral ribs, identically similar in every respect to the Devonian example (Pl. V, fig. 4); but it must be remembered that in the greater number of specimens of *Sp. striata* the ribs upon the lateral portions of the valve augment very much in number by the intercalation of additional ribs at various distances from the beak and umbone, while in *Sp. disjuncta* they are all simple. It is, therefore, easy by this character alone to distinguish the larger number of specimens of the two species, while we cannot deny that some few can hardly be separated. The character of the ribs in the fold and sinus of the Carboniferous and Devonian species are exactly similar; and in both we often find a couple of deeper grooves, which sometimes appear to divide the fold into three portions, as is so common in *Sp. bisulcata*. *Sp. disjuncta* occurs in the Upper Devonian brown grits of Croyde Bay, seven miles west-north-west of Barum; in the neighbourhood of Barnstaple, Braunton, &c.; at South Petherwin, in slates and subordinate limestone; in chloritic

¹ The reader is referred to a very interesting and important paper "On Slaty Cleavage," by Daniel Sharpe, in the 'Quarterly Journal of the Geological Society,' vol. v, p. 74, 1847, in which the author has given an elaborate description and illustration of the many modifications effected on *Spirifera disjuncta* by cleavage. He also observes, that "in determining the species of fossils of the older formations, great difficulties arise from the distortion of form which they have frequently undergone, which sometimes makes it impossible to ascertain the species or even the genus to which they belong. This distortion varies much in specimens from the same locality, and still more so in those from different districts. . . . These differences in the angle at which the cleavage intersects the bedding appear to have had an influence on the amount of distortion of the organic remains, as these are usually most altered in form where the angle of incidence of the planes is the least. . . . The distortion of the organic remains, in each bed, is in proportion to its cleavage; in the slates they are extravagantly distorted, in the limestones slightly so, while in the soft ochreous beds, in which there is little cleavage, the fossils have preserved their form nearly unaltered. . . ." &c.

slate at Tintagel, &c.; in the Middle Devonian limestone, at Woolborough, near Newton Abbot; at Ilfracombe, Barton, Lummaton, and Hope's Nose, near Torquay, &c. Also in slaty and sandy beds between thick Carboniferous Limestone and genuine Old Red Sandstone in various localities in the County of Cork, Ireland. On the Continent it abounds at Ferques, in the Boulonnais, &c., in France; at Chimay, &c., Belgium; Ferrones, Spain; in Nassau, Stolberg, near Aix-la-Chapelle; in Russia, America, China, &c.

? *SPIRIFERA CANALIFERA*, Val. (sp.) in *Lam.*, 1819. Pl. VI, fig. 9.

TEREBRATULA CANALIFERA, Val. in *Lam.* Hist. Nat. des Animaux sans Vertèbres, vol. vi, p. 254, 1819. *Encycl. Méthodique*, pl. ccxlv, fig. 5; and *Dav.*, Notes on an Examination of Lamarck's Species of Fossil Terebratulæ, *Annals and Mag. of Nat. Hist.*, 2nd series, vol. v, p. 442, pl. xiv, fig. 40, 1850.

TEREBRATULITES APERTURATUS, Schloth. *Nachträgen zur Petrefactenkunde*, pl. xvii, fig. 1, 1822.

SPIRIFERA APERTURATA, Phillips. *Pal. Foss. of Cornwall, Devon, and West Somerset*, p. 77, pl. xxx, fig. 133, 1841.

Spec. Char. Shell somewhat transversely sub-rhomboidal, rather wider than long; hinge-line shorter than the width of the shell; cardinal extremities angular. Valves convex, sometimes gibbous. Dorsal valve semicircular; mesial fold sharply defined, of moderate elevation, and flattened along its middle; the surface of the valve is ornamented by a variable number of simple or bifurcating ribs, these being smaller on the fold than on the lateral portions of the valve. Ventral valve deeper or more convex than the opposite one, with a wide, shallow sinus, this valve and its sinus being ornamented similarly to the dorsal one. Beak more or less incurved, area triangular, and of variable breadth. Fissure partly arched over by a pseudo-deltidium. Proportions variable. Length 22, width 23, depth 20 lines.

Obs. At p. 77 of his work on the 'Palæozoic Fossils of Cornwall, Devon, and West Somerset,' Professor Phillips mentions that only one specimen had occurred to his observation, from the coarse slaty rocks of Linton, in Devonshire, and that it may be viewed as identical with the fossil of Bronn and Schlotheim, though there is a rather nearer approach to equality between the mesial and lateral ribs. Not having been able to procure a sight of the fragment described by Phillips, or of any other British specimen, I must quote this species as a British fossil entirely upon the authority of Professor Phillips. *Sp. canalifera* has much of the general shape of *Sp. disjuncta*, but will be easily distinguished on account of the bifurcation of its lateral ribs, a feature not observable in *Sp. disjuncta*. When examining Lamarck's original types of fossil Terebratulæ, which had been kindly lent me by the Administration of the Jardin des Plantes, I had occasion to notice that the *Terebratula canalifera* of Val. in Lam. belonged to the genus *Spirifera*, and that reference

is made by that author to pl. 244, fig. 5, of the 'Encyclopédie Méthodique,' for a figure of the type of his species, and which belongs to the well-known Devonian shell subsequently described and figured by Schlotheim in 1822, under the name of *Terebratulites aperturatus*, and I am glad to find that Valenciennes' or Lamarck's name is now made use of by the generality of palæontologists. It is at the same time necessary to mention that Valenciennes' var. (pl. 244, fig. 4, of the 'Encyc. Méth.') is a specimen of *Sp. disjuncta*, Sow., and not of *canalifera*.

Sp. canalifera occurs in the Devonian limestone of Paffrath, near Cologne, in Prussia.

Not having been able to procure the sight of a specimen of the following four so-termed species, and as the illustrations given by Phillips are extremely incomplete, I will reproduce the original descriptions and figures simply as memoranda, not wishing to take any responsibility as to their specific value. It is also uncertain whether the rocks containing the first three are Devonian, or whether they should not be classed as Carboniferous.

?? SPIRIFERA MESOMALA, *Phillips*. Pl. VI, fig 8.

SPIRIFERA MESOMALA, *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 78, pl. xxxi, fig. 137, 1841.

"*Characters*. Depressed, transversely elongated, radiated from the beak, with many small lateral and a few broad, flat, mesial undulations. It is this latter circumstance which attracted my attention. The mesial ridge of the upper valve of ordinary Spirifera is here a broad, flat, acute-edged fold, margined by two broad grooves, beyond which small radiating ribs cover the sides. *Locality*. In North Devon, Brushford."

?? SPIRIFERA OBLITERATA, *Phillips*. Pl. VI, fig. 10.

SPIRIFERA OBLITERATA, *Phillips*. Pal. Foss. of Cornwall, Devon, &c., p. 78, pl. xxxi, fig. 135, 1841.

"Semicircular, more than twice as wide as long, very convex, with extended acute terminations to the cardinal area; surface radiated with rounded, very little prominent undulations, crossed by distant lines of growth. Mesial sulcus slight, placed between two obtusely convex radiations much larger than the rest. Allied to *Sp. speciosa*, and the species ranked with *Sp. rhomboidea*, *Sp. fusiformis*, &c., in the Mountain-limestone. *Locality*. In North Devon, Brushford."

? ? *SPIRIFERA MEGALOA*, *Phillips*. Pl. IX, fig. 23.

SPIRIFERA MEGALOA, *Phill.* Pal. Foss., pl. xxx, fig. 140, 1841.

“*Characters*. General figure rhomboidal (?), gibbous; surface radiated with very few, *extremely broad*, transversely imbricated ridges and hollows. Having seen only the crushed specimens here represented, I am not able to present a more perfect description, but I presume it will be easily recognized. *Locality*. North Devon, Brushford.”

? ? *SPIRIFERA RUDIS*, *Phillips*. Pl. IX, figs. 24 and 25.

SPIRIFERA RUDIS, *Phill.* Pal. Foss., p. 78, pl. xxxi, fig. 136, 1841.

“The specimens figured are all that have fallen under my notice, and not sufficient to allow of precise definition. I found them in a hard black limestone, among the slaty rocks of Croyde Bay, on the south side of Baggy Point. *Locality*. Baggy Point, North Devon.”

SPIRIFERA LÆVICOSTA, *Val.* (sp.) in *Lamarck*. Pl. VIII, figs. 4, 5.

TEREBRATULA LEVIS È MAJORIBUS, &c., *Beuth.* *Juliae et Montium Subterranea*, p. 146, No. 158, 1776.

— *LEVICOSTA*, *Val.* in *Lamarck*. *Hist. Naturelle des Animaux sans Vertèbres*, vol. iv, p. 254, 1819; and *Davidson*, “Notes on an Examination of Lamarck’s Species of Fossil Terebratulæ,” *Annals and Mag. of Nat. Hist.*, 2nd series, vol. v, p. 443, 1850.

TEREBRATULITES OSTIOLATUS, *Schlotheim*. *Nachträgen zur Petrefactenkunde*, pl. xvii, fig. 3, 1822.

SPIRIFER — *Von Buch*. *Ueber Delthyris oder Spirifer und Orthis*, p. 33, 1837; and *Mémoires Soc. Géol. France*, vol. iv, p. 178, pl. viii, fig. 1, 1840.

— — *Steining*. *Eifel*, p. 33.

— — *Bronn*. *Index Palæontologicus*, p. 1178, 1848.

— — *Quenstedt*. *Handb. der Petrefactenkunde*, p. 477, pl. xxxviii, fig. 17, 1851.

— — *Phillips*. *Pal. Foss. of Cornwall, Devon, and West Somerset*, p. 76, pl. xxx, fig. 132, 1841.

LEVICOSTA, *M'Coy*. *British Pal. Fossils*, p. 375, 1852.

— — *Schnur*, in *Dunker u. Von Meyer’s Palæontographica*, vol. iii, pl. xxxii^b, fig. 3, 1853.

Spec. Char. Shell rotundato-quadrate, slightly wider than long; valves very convex; hinge-line hardly as wide as the shell; ventral area concave, of moderate width; beak

slightly incurved, with a smooth mesial sinus extending from the extremity of the beak to the front, and to which in the dorsal valve corresponds a rather wide, smooth, prominent, mesial fold. Each valve is ornamented by from twenty to thirty simple, obtusely rounded ribs.

Length 15, width 15, depth 13 lines.

Obs. No reference as to figure is given by Lamarck; but it is stated that the fossil was found at Bensberg, near Cologne. M. Valenciennes informed me, when sending his type for my inspection, and which is preserved in the Muséum du Jardin des Plantes in Paris, that he had received the shell from which he established the species in 1817 from Professor Nöggerath, while on a visit to Bonn; and it was figured by myself in the 'Annals of Nat. Hist.' for 1850. A similar specimen was illustrated and described in 1822 by Schlotheim, under the designation of *Terebratulites ostiolatus*, and subsequently placed among the Spirifers by Von Buch, and by Bronn in König's genus *Trigonotreta*. But since Valenciennes appears to have been the original describer of the species, it should retain the name of *laevicosta*, and I am glad to find that Professors Schnur, M'Coy, Morris, and several other palæontologists, have adopted this view. To Professor Quenstedt we are indebted for an excellent figure, showing the shape and position of the spiral appendages.

Sp. laevicosta does not appear to be a very common fossil in Great Britain. It occurs in the Devonian shales of the Valley of the Rocks, Linton, North Devon. Phillips's figured specimen, which is a mere incomplete impression of the ventral valve, is preserved in the Museum of the Geological Survey. It has also been found in Middle Devonian limestone near Newton Abbot. On the Continent it is common in the Eifel, at Chimay, &c.

SPIRIFERA SPECIOSA, *Schlotheim* (sp.). Pl. VIII, figs. 6—8.

TEREBRATULITES SPECIOSUS, *Schlotheim*. Taschenbuch für die gesammte Mineralogie, pl. ii, fig. 9, 1813.

— PARADOXUS, *Id.* Ib., pl. ii, fig. 6.

— SPECIOSUS, *Id.* Nachträgen zur Petrefactenkunde, pl. xvi, fig. 1, 1822.

— INTERMEDIUS, *Id.* Ib., fig. 2.

TRIGONOTRETA SPECIOSA, *Koenig*. Icon. Foss. Sectiles, iii, pl. vi, fig. 71.

— — *Bronn*. Lethæa Geog., pl. ii, fig. 15.

DELTHYRIS MICROPTERA, *Goldf.*, in Von Dechen's Translation of Sir H. De La Beche's Manual, p. 525, 1833.

SPIRIFER SPECIOSUS, *Von Buch*. Ueber Delthyris oder Spirifer und Orthis, p. 35, 1837; and Mém. Soc. Géol. de France, vol. iv, p. 180, pl. viii, fig. 4, 1840.

— — *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 77, pl. lviii, fig. 134, 1841.

- ? *SPIRIFER COSTATUS*, Sow. Trans. Geol. Soc., 2nd series, vol. v, pl. lv, figs. 5, 6.
- *SPECIOSUS*, D'Archiac et De Verneuil. Descriptions of the Fossils in the Older Deposits of the Rhenish Provinces, Trans. Geol. Soc., 2nd series, vol. vi, pp. 395 and 408, pl. xxxviii, fig. 5.
- *SPECIOSUS* = *INTERMEDIUS* und *PARADOXUS*, Bronn, Index Palæontologicus, p. 1181, 1848.
- — *M'Coy*. British Pal. Foss., p. 376, 1852.
- — *Schnur*, in Dunker u. Von Meyer's Palæontographica, vol. iii, pl. xxxii, fig. 2, 1853.

Spec. Char. Shell transversely fusiform; hinge-line straight and long; cardinal angles and lateral margins gradually attenuated; valves moderately convex; beak small, incurved; ventral area of moderate breadth; sinus wide, regularly concave, extending from the extremity of the beak to the front, and to which corresponds a mesial fold in the opposite valve. Each valve is ornamented by from twelve to eighteen, or more, simple rounded ribs, the surface of the shell being regularly and closely crossed by sharp, concentric lines or laminæ of growth.

Length 9, width 18 lines; but the shell has attained larger proportions.

Obs. Characteristic specimens of this species occur in the Middle Devonian shales of Hope's Nose and Meadfoot, near Torquay. Professor M'Coy mentions its occurrence at Fowey, East Looe, St. Veep, Polruan, &c., in Cornwall; but from these localities no specimens have come under my notice. On the Continent it is common in the Eifel, at Convin in Belgium, and Luga; also in the States of Ohio and New York in America.

This appears to be a very variable shell, and has been somewhat differently interpreted by palæontologists. It may therefore be desirable to enter upon some details in connection with its history.

The first notice we can find of *Spirifera speciosa* is contained in p. 52 of Leonhard's 'Taschenbuch,' for 1813. The shell is not described, but mentioned by Schlotheim in the following words:—"Terebratulites speciosus, aus der Gegend von Belinzona: meine Sammlung;" and in the accompanying pl. ii, fig. 9, he gives a representation of his species. The shell is fusiform, with a simple fold and sinus, each valve being ornamented by some ten or twelve ribs, the whole closely traversed by concentric lines or slightly projecting laminæ. Subsequently, in 1822, and at p. 252 of his 'Die Petrefactenkunde,' Schlotheim again mentions his species, and gives a good illustration of it in pl. xvi, fig. 1, of his work. This specimen shows about twenty-eight rounded ribs in each valve. Here, also, for the first time, he introduces his so-termed *Terebratulites intermedius* (pl. xvi, fig. 3), which the generality of palæontologists consider to be a simple variety or variation in shape of *Sp. speciosa*, with about twelve ribs upon each of its valves. Both are stated to have been derived from the Eifel.

In 1833 Goldfuss appended a list of fossils to Von Dechen's translation of Sir H. De La Beche's 'Manual of Geology,' and introduced a number of new names without description or illustration, and has thus furnished us with another instance of the confusion

that can be created by the pernicious effect of manuscript names. Here we find for the first time, at p. 525—" *Delthyris micropterus*, Goldf., *T. intermedius*, Schloth.—Eifel, Gloucestershire, Herefordshire, &c.;" but no such species occurs in the counties named.

Now, I cannot understand why he should have introduced this new name, since he considers it and Schlotheim's *T. intermedius* to be synonymous! Here we find also—

" *Delthyris macropterus*, Goldfuss, = *T. speciosus* and *T. paradoxus*, Schl., of the Eifel."

Therefore, according to Goldfuss, *Sp. speciosus* and *Sp. paradoxus*, and *Sp. macropterus*, would be synonymous, and in default of description we are bound to take him at his word.

In 1837, at p. 35, of his 'Ueber Delthyris,' &c., Von Buch enlarges upon the subject of *Spirifer speciosus*, and adds—"Among the principal varieties of this species we may reckon the following—

"1. *Sp. speciosus micropterus*, Goldf., with from ten to eighteen ribs on each side of the fold." But the celebrated Prussian palæontologist is, I think, mistaken when stating that *Sp. distans*, Sow., may belong to this variety.

"2. *Sp. speciosus intermedius*, Schloth. (*macropterus*, Goldf.). Six to eight large ribs on each of the lateral portions of the valve, or from twelve to sixteen ribs, without counting the fold."

I must here express my surprise that, after Goldfuss has so distinctly intimated that his *Delthyris micropterus* = *T. intermedius*, Schloth., and that his *Delthyris micropterus* = *T. speciosus* and *T. paradoxus*, another interpretation should have been put upon the matter by Von Buch.

"3. *Spirifer speciosus alatus*." This last is a Permian shell, which appears to be closely related to *Sp. macropterus*.

I consider Von Buch likewise mistaken when he states that *Sp. convolutus*, Phillips, *Sp. fusiformis*, Sow., and *Sp. rhomboidalis*, Phillips, may be varieties of *Sp. speciosus*, the character of the mesial fold and sinus being sufficient to negative such a conclusion.

At p. 1181 of his 'Index Palæontologicus' (1848), Dr. Bronn gives us a long list of synonyms and references to Schlotheim's *Sp. speciosus*; and among them we find *Delthyris microptera*, Goldfuss, *Hysterolites hystericus*, Schloth.; and as named varieties, β . *Terebratulites intermedius*, Schloth., and γ . *Terebratulites paradoxus* of the same author. But I must confess that the figures given by Schlotheim of his *Hysterolites hystericus* lead me to believe that it cannot be considered as a synonym of *Sp. speciosus*.

In vol. v of the 'Transactions of the Geological Society of London,' 2nd series (May, 1840), Sowerby describes and figures some very imperfect and distorted casts and impressions of a fusiform Spirifera, not unlike *Sp. speciosus* or *Sp. paradoxus*, under the denomination of *Sp. costata*, and adds, "(= *S. speciosa* of the Eifel?)," implying that it might be synonymous with Schlotheim's species; and in 1852 Professor M'Coy ('British Pal. Fossils,' p. 376) unhesitatingly places *Sp. costata* as a synonym of *Sp. speciosa*. Phillips, in his 'Figures and Desc. of the Pal. Fossils of Cornwall, Devon, &c.,' p. 77, 1841, adopts Sowerby's *Sp. costata*, but observes, at the same time, that it "certainly resembles *Sp*

speciosus of Bronn, 'Leth. Geog.,' pl. ii, fig. 15 (which is not quite like *Tereb. speciosus*, Schloth., pl. xvi, fig. 1); but that its lateral ribs are much more decided even in a cast—it appears distinct. It seems also nearly allied to *Sp. undulata*, Sow., from the magnesian limestone of East Trichley." But I would here again observe that all Phillips's and Sowerby's figures of *Sp. costata*, which represent very badly preserved and distorted casts, have not angular, but rounded ribs, just as in *Sp. undulata* and *Sp. speciosa* proper. We would not, therefore, venture to admit *Sp. costata* as a distinct species upon such unsatisfactory material.

We now come to the 'Tables of the Distribution of the Fossils in the Older Deposits of the Rhenish Provinces,' by Viscount D'Archiac and M. De Verneuil, p. 395, 1840, where we find *Hysterolites paradoxus*, and *H. vulvarius*, Schlotheim, given as synonyms of *Sp. speciosus*; and this leads me to fear that our distinguished friends may have intended to allude only to the *Terebratulites paradoxus* of Schloth., *Hysterolithes vulvarius* of that author belonging to the genus *Orthis*.

Further on, at p. 408 of the same memoir, in an appendix by J. De Carle Sowerby, we find—"Pl. xxxviii, fig. 5, *Sp. speciosus*, Schloth. . . . *Sp. macropterus*, var., Goldfuss, MS.?: there is no character that I am aware of to distinguish this form from *Sp. speciosus* of Schlotheim; but, as the internal structure exhibited by the cast is totally different from that of *Sp. micropterus* (?), I quote Goldfuss with doubt."

Sowerby further on considers the last-named shell, as a synonym of *Hysterolites hystericus*, Schloth., to be specifically distinct; a view also advocated by De Verneuil, at p. 394 of his 'Tables:' and here commences another phasis in the confusion involving these several Devonian so-termed species.

In 1851 Professor Schnur considered *Sp. micropterus*, Goldf., to be a variety of *Sp. ostiolatus*; and later, in his work on the Eifel Brachiopoda, 'Palæontographica,' vol. iii, p. 197, places *Sp. intermedius*, Schloth., among the varieties of *Sp. speciosus*; considers *Sp. paradoxus*, Schlotheim, to be a distinct species; *Delthyris macropterus*, Goldf., being mentioned as a synonym; and proposes a third species by the name of *Sp. subcuspidatus*, with which he locates *Delthyris micropterus*, Goldf., and *Hysterolites hystericus*, Schloth., as synonyms.

And lastly, in his 'Die Brachiopoden des Rheinischen Schichtensystems in Nassau,' p. 21 (1855), Dr. Sandberger admits as a species *Sp. macropterus*, Goldfuss, and considers *Sp. mucronatus* and *Sp. micropterus*, Goldfuss, as varieties of the same.

From all this diversity of views it is difficult to arrive at any positive opinion with reference to the synonyms of *Sp. speciosa*; but I am inclined to believe that *Sp. intermedia*, *Sp. paradoxa*, Schloth., *Sp. costata*, Sow., *Sp. macroptera*, and *Sp. microptera*, Goldfuss, may all be varieties or modifications in shape of a single very variable species. My material in German specimens of the shells here named is not, however, as extensive as I could have desired, and therefore trust that the subject will be reconsidered by some of the German palæontologists.

Schlotheim's first notice of *Sp. paradoxus* will be found in the 'Taschenbuch für die gesammte Mineralogie' for 1813, pl. ii, fig. 6. This figure represents the internal cast of a very fusiform Spirifer, with a smooth sinus, and about thirty-eight rounded ribs, and not very unlike specimens 11 and 13 of our Pl. VIII.

We will therefore provisionally refer our figs. 6, 7, 8, to *Sp. speciosa* proper, and figs. 9, 10, 11, and 13 to the var. *paradoxa* of Schlotheim.

The imperfect specimen, fig. 12, from the Middle Devonian shales of West Ogwell, I am unable to identify with any degree of certainty. It has been referred by the Survey palæontologists to *Sp. Bouchardii*, and we find it so registered at p. 151 of the second edition of Professor Morris's 'Catalogue of British Fossils.' The wide triangular area exhibited by this specimen leads M. Bouchard and myself to question the identification, the area of *Sp. Bouchardii* being in all the very many specimens hitherto found, linear, narrow, and parallel, and we can perceive no median rib in the sinus of the ventral valve of our English specimen, although this rib, which exists in well-shaped specimens of *Sp. Bouchardii*, is at times absent or obscurely defined. In external shape and angularity of its ribs, the shell under notice resembles some American examples of Conrad's *Delthyris mucronata*; but here again we have a linear, parallel area, and not a triangular one, as seen in the Ogwell specimen.

M. Bouchard objects to the assimilation made by Herr F. Roemer, and some other palæontologists, of *Sp. Bouchardii* with *Sp. comprimatus*, Schlotheim ('Min. Taschenbuch,' tab. ii, fig. 8); but, not having seen the original specimen, I dare not venture to express a positive opinion upon the question, and especially as Schlotheim's figure differs much in general shape from the shell to which De Verneuil has applied the designation of *Bouchardii*. M. Bouchard informs me that he has never seen any true example of *Sp. Bouchardii* from the Eifel, and that he is convinced that the specimen of *Sp. Bouchardii* figured by F. Roemer, under the denomination of *Sp. comprimatus*, Schloth. ('Rheinisch. Uebergangsgeb.,' pl. iv, fig. 3, 1844), was obtained at Labuyssière-sur-Sambre, in Belgium; and I may add that I possess specimens from that locality identical in shape and character with Roemer's figures. Up to the present time I have not seen any true British example of *Sp. Bouchardii*.

SPIRIFERA SUB-CUSPIDATA, *Schnur*. Pl. VIII, figs. 14, 15.

SPIRIFER SUB-CUSPIDATUS, *Schnur*. Programm, &c., die Brachiopoden aus dem Uebergangsgebirge der Eifel, p. 11, 1831.

— — — *Id.* Dunker's Palæontographica, vol. iii, p. 202, pl. xxxiv, fig. 1, and pl. xxxiii, fig. 3, 1853.

Spec. Char. Shell transversely semicircular, or obscurely sub-pentagonal; hinge-line as long as the width of the shell; cardinal angles acute, sometimes prolonged, with tapering

extremities; valves convex, with a smooth fold in the ventral valve. From twenty to twenty-four angular ribs ornament the surface of each valve, the whole being traversed by numerous concentric lines or slightly prominent laminae. Beak almost straight; area flat, triangular, comparatively large; fissure partly arched over by a pseudo-deltidium. Two specimens have measured—

Length 10, width $14\frac{1}{2}$, depth 6 lines.

„ 7, „ 17, „ 7 „

Obs. Professor De Koninck and M. Bouchard are of opinion that the shell above described should be referred to *Sp. sub-cuspidatus*, Schnur, and that it is specifically distinct from the *Hysteriolites hystericus* of Schlotheim (?). Professor Schnur, however, mentions as synonyms of his species *Delthyris microptera*, Goldfuss, and *Hysterolites hystericus* of Schlotheim; but, if this was his opinion, I cannot understand why he did not adopt one of the two designations, instead of proposing a new name for the shell under description.

Sp. sub-cuspidata occurs in the Middle Devonian limestone of Woolborough, near Newton Abbot, and at Hope's Nose, near Torquay. On the Continent it is a common fossil in the Eifel.

SPIRIFERA HYSTERICA, *Schlotheim* (?). (sp.) Pl. VIII, figs. 16, 17.

HYSTERIOLITES HYSTERICUS, *Schlotheim*. Erklärung der Abbildungen der zu diesem Werke gehörigen Kupfertafeln, Petrefactenkunde, pl. xxix., fig. 1 ^{a, b}, 1822.

SPIRIFER MICROPTERUS, *D'Archiac*, *De Verneuil*, and *J. De C. Sow.* Descript. of the Fossils of the Older Rhenish Provinces, Trans. of the Geol. Soc., 2nd series, vol. vi, pp. 394 and 408, pl. xxxviii, fig. 6: (not of *Goldfuss*?).

Spec. Char. Shell transversely semicircular or sub-pentagonal; hinge-line almost as long as the width of the shell; dorsal valve moderately convex; fold simple, sharply defined, rounded; ventral valve deeper than the opposite one, with a shallow sinus. Surface of each valve ornamented by from twenty-six to thirty simple ribs; beak slightly incurved; area triangular, of moderate width; fissure partly covered over by a pseudo-deltidium.

Length 12, width 17 lines.

Obs. Impressions and internal casts of the shell under description do not appear rare in the Middle Devonian (?) yellowish grits of Linton, in North Devon; but the absence of the shell itself precludes the possibility of our arriving at a positive conclusion as to its specific identification.

In external shape, character of fold, and number of ribs, it so nearly approaches Schlotheim's figures of *H. hystericus* that I have ventured to provisionally leave it under that designation. It also closely resembles the figures given by J. De C. Sowerby in

pl. xxxviii, fig. 6, of the 'Geol. Transactions,' above quoted; which figures resemble likewise the original ones of *hystericus* published by Schlotheim. I cannot, however, understand why Sowerby should have made use of the term *Sp. micropterus*, Goldfuss, for his specimens, since he admits that they agree with *Hysterolites hystericus*, but which last he stamps as a synonym of *Sp. micropterus*.

We may now inquire what is *H. hystericus*, Schlotheim; and, in the absence of any description or well-authenticated specimen, the question can be answered only by a close examination of the author's figures. These consist of internal casts of the dorsal and ventral valves of a Spirifer imbedded in a slab of shale or grit, and which will answer to the following description:

Shell transversely semicircular or sub-pentagonal; hinge-line about as long as the width of the shell; valves convex, with a smooth mesial fold in the dorsal valve, to which corresponds a similar sinus in the opposite one; surface of each valve ornamented by some twenty angular ribs, the widest of which does not much exceed one line in breadth; length 14, width 20 lines; and this description would suit equally well to our Linton specimens. It has been said that the surface of *H. hystericus* was crossed by concentric lines or laminae similar to those of *Sp. speciosa* and of other species; but these are not observable in Schlotheim's figures of internal casts any more than they could be seen on the Linton specimens, and may have been present in both had we the shell itself to examine. The subject of this identification must remain an unsettled question until more perfect material and direct comparisons can be effected between our Linton specimens and Schlotheim's original ones of *hystericus*.

? SPIRIFERA CULTRIUGATA, Roemer. Pl. VIII, figs. 1, 2, 3.

SPIRIFER	CULTRIUGATUS,	Roemer.	Rheinisch. Uebergangsgeb., p. 70, pl. iv, fig. 1, 1844.
—	—	Roemer.	Beitrage zur geologischen Kenntniss der nordwestlichen Harzgebirges, in Dunker's Palæontographica, pl. xv, 1852.
—	—	Schnur.	Palæontographica, vol. iii, pl. xxxiii, fig. 1, 1853.
—	—	Sandberger.	Die Brachiopoden der Rheinischen Schichtensystems in Nassau, pl. xxxii, fig. 4, 1855.

Spec. Char. Shell large, transversely semicircular; hinge-line usually rather shorter than the width of the shell; dorsal valve convex, at times gibbous, with a large prominent fold or central rib, and six or seven strong simple ribs on each of the lateral portions of the valve; ventral valve convex, with a similar number of ribs and a wide median sinus; beak of moderate proportions, and incurved; area triangular; fissure large, partly arched over by a pseudo-deltidium; proportions variable, two British specimens have measured—

Length 1 inch 10 lines, breadth $2\frac{1}{2}$ inches.

„ $2\frac{1}{2}$ inches, „ 3 inches 9 lines.

Obs. This large *Spirifer* occurs plentifully, but in a very distorted and compressed condition, in the state of internal casts and impressions, in the Devonian grits of Looe, in Cornwall.

With such imperfect material at our command, it is hardly possible to arrive at an exact specific identification; but the less injured specimens resemble, by their general aspect and character of ribs and fold, some similar casts of *Sp. cultrijugatus* I have received from the Eifel district, and which were sent to me so named by Herr F. Roemer. In all the figures published by Roemer, Schnur, and Sandberger, of *Sp. cultrijugatus*, the ribs on the lateral portions of the shell are simple, and do not exceed about twenty on each valve; but in a specimen so named in my possession from the Falls of the Ohio, near Louisville, in America, and which I received likewise, some years ago, from Herr F. Roemer, the ribs are small, in some places bifurcated, and numbering about thirty-four in each valve. Some of our British examples bear, also, a certain resemblance to the *Spirif. socialis* of Krantz, from the Devonian beds of Menzenberg;¹ but it is very difficult to be certain while comparing such imperfect distorted internal casts.

SPIRIFERA UNDIFERA, *F. Roemer*. Pl. VII, figs. 1—10.

SPIRIFER UNDIFERUS, *F. Roemer*. Rheinisch. Uebergangsgeb., p. 72, pl. vi, fig. 6, 1844.

— — *Schnur*, in *Dunker's Palæontographica*, vol. iii, p. 204, pl. xxxiv, fig. 3 *a, b, c, d*, 1853.

— — *Sandberger*. Die Brachiopoden Rheinischen Schichtensystems, p. 18, pl. xxxi, fig. 8, 1855.

Spec. Char. Shell transversely or longitudinally oval; hinge-line less than the width of the shell; cardinal angles rounded; dorsal valve moderately convex; mesial fold broad, more or less sharply defined, of small elevation, and either slightly longitudinally depressed or obtusely rounded. From sixteen to twenty-eight flattened or but slightly rounded ribs ornament the surface of each valve. Ventral valve rather deeper than the opposite one; sinus broad, varying in depth, with one or two faintly marked longitudinal ribs on either of its sides; beak tapering, moderately produced and incurved; area triangular, wider than high; fissure partly arched over by a pseudo-deltidium. The surface of the valves is regularly crossed by numerous fine, contiguous, concentric, serrated ridges, &c. Proportions variable; three specimens have measured—

Length 14, width 16, depth 10 lines.

„ 20, „ 19, „ 13 „

„ 15, „ 20, „ 11 „

¹ 'Ueber ein neues bei Menzenberg aufgeschlossenes Petrefakten-Lager in den Devonischen Schichten,' tab. viii, fig. 3.

Obs. Many examples of this very variable species bear so great a general resemblance to the Carboniferous *Sp. ovalis*, and to its transverse variety, *Sp. hemisphærica*, M'Coy, that I am in no way convinced we are justified while making use of a distinctive denomination for the Devonian shell.

It has been urged that, in perfectly preserved examples of *Sp. undifera*, the surface is regularly crossed by numerous concentric, contiguous striæ or ridges, while in *Sp. ovalis* the surface is smooth; but it must likewise be borne in mind that we but very rarely meet with any Carboniferous shells so perfectly preserved as to exhibit their delicate outer surface, the larger number being decorticated; and this is also the condition in which we find almost all our British specimens of *Sp. undifera*.

Having requested Messrs. Young and J. Thompson to kindly search for some well-preserved examples of the Carboniferous *Sp. ovalis*, they were so fortunate as to find one or two at Corrieburn and Brockley, in Scotland, in which the outer surface was closely covered with numerous fine concentric striæ or ridges, very nearly resembling those observable in *Sp. undifera*.

Sp. undifera is a common shell in the Middle Devonian limestone of Woolborough Quarry, near Newton Abbot, and has been also found in that of Barton and Lummaton, near Torquay. On the Continent it occurs in the Eifel, in Nassau, at Ferques, &c.

SPIRIFERA UNDIFERA, var. UNDULATA, *F. Roemer*. Pl. VIII, figs. 11—14.

SPIRIFER CURVATUS, *Schloth.*, var. UNDULATUS, *F. Roemer*. Rheinisch. Uebergangsgeb., p. 70, pl. iv, fig. 5, 1844.

— UNDIFER, *Schnur*, in Dunker's Palæontographica, vol. iii, p. 204, pl. xxxiv, fig. 9 *g* and *h*, 1853.

Spec. Char. Shell transversely oval; hinge-line shorter than the width of the shell; cardinal angles rounded; dorsal valve convex; mesial fold simple, wide, divided along the middle by a shallow, longitudinal depression or groove, each valve being ornamented with from twenty to thirty rounded or slightly angular ribs, of which (in some specimens) a certain number are due to the bifurcation or intercalation of additional ribs at variable distances from the beaks. Ventral valve rather deeper than the opposite one, with a sinus of variable width and depth, flattened along the middle, and with one or two feebly marked ribs along its sides; beak moderately produced and incurved; area triangular, of moderate size. Surface of the shell regularly crossed by numerous concentric ridges, as in the type *undifera*. Proportions variable.

Length 18, width 25, depth 14 lines.

Obs. After very considerable hesitation and uncertainty, I have ventured to refer figures 11 to 14 of our plate to a well-marked variety or modification in shape of *Sp. undifera*, and this notwithstanding the bifurcation and intercalation of some of the ribs, which is

not a character or feature of Roemer's type. I have been led to this impression from the study of fig. 9, *g* and *h*, of Schnur's *Sp. undifera*; and it appears to me that Dr. Sandberger is, perhaps, mistaken while excluding this modification from the varieties of the last-named species. I possess, likewise, a similar specimen from the Eifel, sent me some years ago by Herr F. Roemer, and labelled *Sp. curvatus*, Schl., var. *undulatus*, F. Roemer, and this, although quite distinct from Schlotheim's figures of *Sp. curvatus*, which represents a smooth shell without lateral ribs, does closely resemble some varieties of the shell we are at present describing. I may, however, be mistaken in my appreciation of this matter, but have been unable to identify the shell with any other known Devonian species, and could hardly venture to apply to it a new specific denomination. When we examine a large number of specimens of *Sp. undifera* and of the variety (?) *undulata*, we can perceive a far greater connection between the two than the necessarily limited selection of illustrations will here convey, and this leads me to believe that the whole series of specimens figured in Pl. VII. do probably belong to a single but variable species. We find similar modifications to occur with the Carboniferous *Sp. ovalis*, *Sp. pinguis*, and its variety *Sp. rotundata*. Indeed, the resemblance between these Devonian shells and those last named are often so very striking as to almost lead one to believe that they are all mere modifications in shape of a single species.

Sp. undifera, var. *undulata*, occurs plentifully in company with *Sp. undifera* in the Middle Devonian limestone of Woolborough Quarry, near Newton Abbot.

SPIRIFERA NUDA, Sow. Pl. IV, figs. 17—24.

SPIRIFERA NUDA, Sow. Trans. Geol. Soc., 2nd series, vol. v, pl. lvii, fig. 8.

— PULCHELLA, Sow. Ibid., fig. 9.

— NUDA, Phillips. Pal. Foss., p. 78, pl. xxxi, fig. 138, 1841.

SPIRIFER NUDUS, F. Roemer, in Dunker's Palæontographica, vol. v, pl. iv, fig. 20, 1855.

Spec. Char. Shell transversely semicircular, wider than long; dorsal valve moderately convex; mesial fold smooth, sharply defined, but of small elevation, one or two rounded ribs existing on either of the lateral portions of the valve close to the mesial fold, the remaining unoccupied lateral space being smooth; hinge-line shorter than the width of the shell; cardinal angles rounded. Ventral valve deeper than the opposite one, with a shallow sinus, and one or two ribs on either side; beak prominent, angular, more or less bent backwards, with its extremity incurved; fissure partly closed by a pseudo-deltidium.

Length 11, width 13 lines; but the shell is usually smaller.

Obs. This interesting species varies to some extent, on account of the greater or smaller proportions of its area and number of ribs. In some specimens the mesial fold and sinus are alone observable, all the remaining portion of the valves being smooth (fig. 17). In other examples (figs. 19—21) there exists one rounded rib on either side of the

mesial fold, while in some specimens the number is two on each side. The ribs on the lateral portions of the valves are also more or less sharply defined in different specimens.

After comparing the original examples of Sowerby's *Sp. nuda* with those of the same author's, *Sp. pulchella* (Sowerby's types being preserved in the Museum of the Geological Society), I arrived at the conclusion that the last-named shell is only a small variety or condition of the first. In Sowerby's two examples which we have figured (23, 24) it will be seen that the same disposition of ribs as described for *Sp. nuda* may be observed in *Sp. pulchella*. We must not omit to call attention to the great similarity of character existing between the Middle Devonian species and the Carboniferous *Sp. triradialis* (vol. ii, p. 49, pl. ix, figs. 4—12), the same disposition of ribs being prevalent; but the Carboniferous shell is usually less transverse, and its beak smaller and more incurved.

Spirifera nuda and its variety *Sp. pulchella* occur in the Middle Devonian limestone of Dockyard, near Plymouth. It is found also at Woolborough, near Newton Abbot, at Barton, and Lummaton, near Torquay, and at Dartington, near Totness, in Devonshire.

SPIRIFERA CURVATA, *Schloth.* (sp.). Pl. IV, figs. 29—32, 33 (?), 34 (?); Pl. IX, figs. 26, 27.

TEREBRATULITES CURVATUS, *Schlotheim.* Nachträgen zur Petrefactenkunde, pl. xix, fig. 2, 1822.

SPIRIFER CURVATUS, *Buch.* Ueber Delthyris, p. 52, 1837.

DELTHYRIS — *Goldf.* in Von. Dechen's Handb., p. 526.

SPIRIFER — *Schnur.* Uebergangsgebirge der Eifel, Brachiopoden, in Dunker's Palæontographica, iii, p. 208, pl. xxxvi, fig. 3.

Spec. Char. Shell variable in shape, transversely oval, and usually wider than long; valves almost equally convex, with a mesial fold of variable elevation in the ventral valve, to which corresponds a sinus in the opposite one; hinge-line shorter than the width of the shell; cardinal angles rounded; beak incurved; ventral area triangular; dorsal one linear; fissure partly covered over by a pseudo-deltidium; surface closely crossed by rows of imbricated, serrated ridges. Proportions very variable; two specimens have measured—

Length 19, width 24, depth 13 lines.

„ 15, „ 16, „ 16 „

Obs. In general shape, the larger number of our British specimens of *Sp. curvata* are undistinguishable from *Sp. glabra*; and, indeed, had we only the decorticate examples usually met with in our Middle Devonian rocks (Pl. IV, figs. 29—32), we should at once identify them with Martin's Carboniferous shell. The difference, as far as we can at present perceive, appears to rest in the external surface or sculpture; for in well-preserved examples of *Sp. curvata* the shell is finely striated and closely imbricated, and decussated by numerous transverse or concentric, finely serrated ridges (Pl. IX, figs. 26, 27), similar in character to those which may be seen in *Sp. bisulcata*, *Sp. undifera*, *Sp. lineata*,

and many other species. Hitherto this kind of sculpture has not, as far as I am aware of, been observed in any specimens of *Sp. glabra*, although numerous concentric lines of growth traverse its surface; hence the, at present, supposed specific difference. Schlotheim's figures are not good, and afford but a very imperfect idea of the shell; but those by Schnur show well the characters of the species, and are quite similar to the more perfect examples we pick up in Great Britain.

Sp. curvata is a common fossil in the Middle Devonian limestones of Woolborough and Chircombe Bridge, near Newton Abbot, at Ramsleigh, near Oggwell, Barton, Lummaton, and Hope's Nose, near Torquay, Dartington, near Totness, Ilfracombe, &c., in Devonshire.

In the Lower Devonian grits of Looe, in Cornwall, occur numerous compressed casts (Pl. IV, fig. 33), which we have, with much uncertainty, referred to the species under description. It is possible that the fragment from Hope's Nose (Pl. IV, fig. 16), described by Phillips under the name of *Sp. microgemma* ('Pal. Foss.', p. 68, pl. xxvii, fig. 116), may belong to *Sp. curvata*, but from such a fragment we cannot form any decided opinion.

SPIRIFERA NEWTONIENSIS, (n. sp. ?) Pl. IX, fig. 21.

Spec. Char. Shell of a somewhat square or pentagonal shape, longer than wide, smooth; lateral margins almost parallel, slightly indented in front; hinge-line as long as the width of the shell. Ventral valve convex; sinus of moderate width and depth; beak nearly straight, acute; area triangular, flat; fissure large. Dorsal valve semicircular, not so deep as the opposite one; mesial fold obscurely defined, rounded, and of moderate elevation.

Length 20, width 18 lines.

Obs. A single specimen of this species (?) from the Middle Devonian limestone of Woolborough Quarry, near Newton Abbot, is preserved in the British Museum. The length of its hinge-line, as well as the shape of its beak and area, will hardly allow us to consider it as a mere variation of shape of *Sp. glabra* or *Sp. curvata*; and as we are not acquainted with any other smooth Devonian Spirifer with which it can be identified, I have reluctantly ventured to describe the shell as a new species.

SPIRIFERA URII, *Fleming*, 1828. Pl. IV, figs. 25—28.

SPIRIFER URII, *Fleming*. British Animals, p. 376, 1828.

ATRYPA UNGUICULUS, *J. Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. liv, fig. 8.

SPIRIFERA — *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 69, pl. xxviii, fig. 119, 1841.

SPIRIFER — *A. Roemer*. Dei Versteinerungen des Harzgebirges, pl. iv, fig. 22.

MARTINIA CLANNYANA, *King*. Cat. of the Organic Remains of the Permian Rocks of Northumberland and Durham, 1848; and Mon. of English Permian Fossils, p. 134, pl. x, figs. 11—13, 1850.

SPIRIFERA URII, *Dav.* Mon. Carb. Brach., p. 58, pl. xii, figs. 13, 14; and p. 267, pl. liv, figs. 14, 15.

Spec. Char. Shell small, suborbicular, rather wider than long; hinge-line shorter than the greatest breadth of the shell; cardinal angles rounded. Dorsal valve semicircular, slightly indented in front, with a narrow hinge-area; nearly flat or but slightly convex—most so at the umbone—with a shallow mesial furrow, commencing at a short distance from the umbone and extending to the front. Ventral valve much more convex and deep than the opposite one, with a comparatively large, incurved beak, and longitudinal furrow, commencing at the extremity of the beak and extending to the front. The area is triangular and of moderate length and width, the fissure being partly arched over by a pseudo-deltidium. The external surface, where perfect, is covered with small spinules. Dimensions variable.

Length about 4, width $4\frac{1}{2}$, depth 2 lines.

Obs. This little species has been fully described in the second volume of this work; therefore all we need now repeat is, that the Permian, Carboniferous, and Upper Devonian specimens are identical in shape and character, as a comparison of specimens, as well as of the figures, will sufficiently prove. This identity has been likewise recognized by Professor Morris, at p. 154 of his 'Catalogue,' by Messrs. Salter, Howse, Kirkby, De Verneuil, and myself, and by Sir R. Murchison, who does not omit to mention, at p. 299 of the second edition of his admirable 'Siluria,' that *Spirifera Uriei*, *Sp. disjuncta*, and *Orthis interlineata*, are found associated together, and that they are common fossils of the Barnstaple or Marwood and Pilton series, as well as in that of South Petherwin; these beds being referred by the above-named and celebrated geologist to the Upper Devonian of this country.¹

¹ This is not the place to discuss the much controverted question relating to the real or supposed value or claims of the Devonian formation, that is to say, whether it should or not be considered a distinct and independent system; but, as I have often to make use of the provisional terms "Upper" and "Middle Devonian" with reference to the fossils described in this monograph, a few lines of explanation may now appear to be absolutely required.

Some geologists have gone so far as to suggest that the so-termed *Devonian*, as a system, could be ad-

Sp. Urvii is exceedingly common in the shape of casts in the brown grits of Marwood, Barnstaple, and Braunton, in Devonshire; and it occurs also in what Mr. Salter considers

vantageously dispensed with; that the lower portion of the strata representing the Siluro-Carboniferous interval should be given to the Silurian, while the upper portion, including the Petherwin, Marwood, and Pilton beds, should form part of the Carboniferous system. The strong notion of the equivalency of the *Devonian* and *Lower Carboniferous* is growing up in some quarters, as well as that of a close affinity and representativeness of the Devonian and Carboniferous forms; but such views are far from having been hitherto satisfactorily proved. At the time I first began my researches among the Brachiopoda, I believed to some extent, along with many others, in the supposed independence of geological systems; but, as I progressed with my geological and palæontological studies, I gradually began to doubt the existence of any *absolute* palæontological demarkation between any contiguous geological systems, and was led to concur with M. De Verneuil, who attaches less importance than do many geologists to those geological and palæontological divisions of the crust of the globe, which he believes to be more in our idea than in nature, and conforming more to the actual state of science than to its complete development. I therefore hasten to declare, that I do not consider the Devonian formation to be an independent system any more than I do the Carboniferous and Permian; all three appearing to me to be connected by a gradual passage of certain species. I am, therefore, quite prepared to admit that a certain number of Brachiopoda have passed from what is termed Upper Devonian into Lower Carboniferous; and some species from the other classes are common to the two periods; certain bivalved *Entomostraca*, for instance, are declared by Mr. R. Jones to be identical, &c. But for all that, if for nothing else but the sake of convenience and reference, I should feel disposed to retain the divisions introduced by Sir R. Murchison and other geologists, when deprived of the fallacious idea of their *absolute* independence.

Mr. J. Beete Jukes informs me that he considers the Carboniferous Slate of Cork to be absolutely contemporaneous with the Carboniferous Limestone of the rest of Ireland, and that the Marwood and Pilton grits of North Devon are also the sandy representatives of the Carboniferous Limestone, and therefore not Devonian at all. The study I have recently made of some of the Brachiopoda collected by Mr. Jukes and the Irish Geological Survey, in the slaty and sandy beds which lie between thick Carboniferous Limestone and genuine Old Red Sandstone at Scariff, and in other localities in the county of Cork, would lead me to agree with Mr. Jukes that these brown grits and slates may be contemporaneous with or equivalent to the North Devon, Marwood, and Pilton beds, whether they be considered as *Upper Devonian* or as *Lower Carboniferous*. They possess several fossils in common, such as *Spirifera disjuncta*, *Sp. cristata*, var., an *Athyris*, probably referable to *A. concentrica*, *Rhynchonella pleurodon*, and some species of *Orthis*, *Chonetes*, and *Productus*, to be hereafter described. The nature, however, of these fossils, as well as the presence of *Cyrtina heteroclita*, associated with *Spirifera disjuncta* in the grits of Reenydonegan Point, at the head of Bantry Bay, would make me pause awhile prior to recognizing these beds to be, strictly speaking, *Carboniferous*, or until it may have been satisfactorily proven that what geologists have hitherto considered as Upper Devonian should in reality form part and parcel of the Carboniferous. Mr. Jukes informs me, moreover, that the beds at Reenydonegan Point, which contain so interesting an assemblage of what I should consider Upper Devonian and Carboniferous Brachiopoda, is up near the top of what he terms the Irish Carboniferous Slate, or 4000 or 5000 feet above the top of the Old Red Sandstone, and that they are full of *Phillipsia pustulosa*, the common Carboniferous Trilobite, and other fossils, apparently common Carboniferous species. These Irish and North Devon grits would therefore, on palæontological grounds, seem to be intermediate beds, connecting the Devonian with the Carboniferous; for there can be no doubt that, taken as a whole, the fauna of the Devonian formation is distinct from that of the Carboniferous, although the two formations may be connected by a gradual passage and mixture of Devonian and Carboniferous species; or, in other words, it is no doubt the truth that there are certain species of fossils common to Devonian beds and the Carboniferous system; but it is not the *whole* truth, for

to be lower beds at Petherwin, in Cornwall. Herr A. Roemer has also found larger examples of this shell in the Devonian beds of Gründ, in the Hartz.

? SPIRIFERA LINEATA, *Martin* (sp.). Pl. IV, figs. 13—15, 16.

CONCHILIOLITHUS ANOMITES LINEATUS, *Martin*. Petref. Derb., pl. xxxvi, fig. 3, 1809.

TEREBRATULA LINEATA et IMBRICATA, *Sowerby*. SPIRIFER MARTINI, *Fleming*.

SPIRIFERA LINEATA, *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 70.
pl. xxviii, fig. 120, 1841.

? — MICROGEMMA, *Phillips*. Ibid., p. 68, pl. xxvii, fig. 116.

there are also some species common to Devonian beds and the *Silurian* system; whilst by far the greater number are neither *Silurian* nor *Carboniferous*, but *intermediate* forms, that is, they represent an *intermediate* period, if it be possible for fossils to do so. The results of Mr. Jukes' examination of these Irish beds, and of their fossils, will be found in the 'Explanations of the Geological Survey of Ireland;' and at pp. 215, &c. (also foot-note, p. 185) of the same author's 'School Manual of Geology.' This subject will, however, require much further examination, and it will be necessary for all the classes of fossils found in the North Devon and South of Ireland brown grits and slates to be carefully compared with *Carboniferous* types, before any positive determination relative to the age of these beds be finally settled. In Ireland we appear to have, first, some Upper *Silurian* rocks, full of marine mollusca, *Brachiopoda*, &c.; then, a very thick formation, of what Mr. Jukes terms Dingle beds, resting conformably on the upper *Silurian*, but covered unconformably by genuine Old Red Sandstone, neither containing any *Brachiopoda*; above this, a very thick succession of slaty and sandy beds or grits, full of marine fossils, and containing a mixture of Devonian and *Carboniferous* species of *Brachiopoda*; and above part of this, again, beds of *Carboniferous* Limestone, full of genuine *Carboniferous* fossils and *Brachiopoda*; while other parts have no limestone over them, but in some places shales, that appear to be Coal-measures, the parts not covered by the limestone being much thicker than those that are.

Mr. Jukes informs me that he has now arrived at the following general conclusions:

- 1st. That the uppermost bed of the true Old Red Sandstone was in existence before any of the beds containing marine Devonian fossils were deposited.
- 2nd. That the Devonian fauna was contemporaneous with the *Carboniferous*, the terms really indicating a geographical and not a chronological distinction. He believes this will ultimately be found to be true for America as well as Europe.
- 3rd. That the so-called Old Red Sandstone of Wales and Scotland belongs to two periods, distinct in their forms of life, the one (containing *Cephalaspis*, &c.) belonging more properly to the Upper *Silurian*, the other being more closely connected with the *Carboniferous*.
- 4th. He would limit the term Old Red Sandstone to the latter; and his first conclusion will then show the confusion produced by using the words "Old Red Sandstone" and "Devonian" as synonymous.

In his valuable paper "On the Upper Old Red Sandstone and Upper Devonian Rocks" ('Journal of the Geol. Soc. of London,' vol. xix, p. 490, &c., 1863), Mr. Salter, with the concurrence of Sir R. Murchison, refers the Marwood and Pilton beds of North Devon to the *Upper Devonian* (*Verneuilii-Schiefer*, &c.). The Petherwin and Landlake group he considers to constitute a lower band also of the Upper Devonian, but not to represent that of Barnstaple or of the Marwood and Pilton series, these last being the equivalents of the Clymenien-Kalk or Cypridiuen-Schiefer of the Prussian geologists, and, perhaps, of the red slates of Morte Bay; so that, in Mr. Salter's opinion, the Marwood and Pilton Beds overlie the Petherwin group.

Spec. Char. Transversely oval, or suborbicular; hinge-line much shorter than the width of the shell; cardinal angles rounded; beaks more or less approximate, and considerably incurved. Ventral valve gently and evenly convex, rarely exhibiting any mesial elevation. Dorsal valve rather deeper than the opposite one, uniformly convex, or presenting a shallow longitudinal depression, apparent only in the proximity of the front, or extending to the extremity of the beak. Area small, with lateral margins obscurely defined; fissure triangular, partially covered by a pseudo-deltidium. Surface of both valves marked by numerous concentric ridges, rarely more than a line apart in any place, but usually very much closer, and from which projected numerous closely packed spines, forming a series of spiny fringes overlapping each other all over the shell. Proportions variable.

Length 12, width 13, depth 8 lines.

Obs. Specimens which appear to agree in shape with Martin's *Sp. lineata* have been found in the Middle Devonian limestone of Woolborough Quarry, near Newton Abbot (fig. 13); while other examples are described and figured by Phillips under the same denomination, from the Upper Devonian beds of South Petherwin and Landlake (figs. 14, 15). In the specimens I have been able to examine, the outer shell-surface was very

Mr. Jukes, on the other hand, informs me that an exploration in North Devon, in 1862, showed him that the red and green slates and sandstones of Morte Bay were precisely like the "Upper Old Red" beds of the western part of Cork, and the section above them, round Baggy Point into Croyde Bay, exactly like the section which always comes above the Upper Old Red in West Cork. He can have no doubt, then, that the beds at the southern end of Morte Bay are the Upper Old Red, in which no trace of a marine fossil has yet been found, either in North Devon or South Cork. He also says that he could see no stratigraphical reason for believing that the Petherwin beds were above or below the Pilton beds. The Pilton beds rise from underneath the Coal-measures on the north and the Petherwin beds on the south, without any evidence, so far as he could see, of any unconformability between the Coalmeasure-slates above and the others below in either locality; neither was the lithological difference between the beds at the two localities very striking, nor greater than might naturally occur in a distance of twenty-five miles. This intervening distance is occupied by a very disturbed basin of crumpled Coal-measures, which also greatly resemble the Coal-measures of the south of Ireland.

The *Middle Devonian* of the Eifel would, anyhow, be represented in England by the Plymouth, Woolborough, Torquay, Dartington, and other similar deposits, and may, perhaps, be susceptible of being divided into several horizons. At Torquay we would, according to Mr. Salter, have the Spirifer-sandstone group of the Rhine; in other places we certainly have the Stringocephalen-Kalk and Calceola-Schiefer or Lenne-Schiefer (Eifel-Kalk of the Prussian geologists). The *Lower Devonian* Mr. Salter considers to be, perhaps, the equivalent of the Old Red Sandstone; the "Tilestones," or Ladbury Shales, being, according to his views, the *Lowest Devonian*.

Mr. Pengelly informs me that, if the entire Siluro-Carboniferous interval is represented by the Old Red Sandstone, as Mr. Jukes would appear to hold, it will follow, he thinks, that the Devonshire lower slates, *i. e.* those below the Torbay, Newton, and Plymouth limestones, are the only Devonian beds we have, all above being Carboniferous; and that, should Mr. Jukes carry out his threat of handing over to the Carboniferous system the Upper Old Red, the lower slates must go too, as he believes them to be on the same horizon. Mr. Pengelly's impression, however, is that the Old Red Sandstone represents the Lower, and the Devonshire or Damnonian beds the Upper, Devonian Period, or Siluro-Carboniferous

imperfectly preserved; but Phillips describes those he has seen and figured as “Concentrically undulated, with concentric, raised, small ridges, across which run fine, interrupted, longitudinal lines, producing a minute crenulation, or even granulation;” and these markings are, no doubt, due to the concentric spiny fringes which cover the surface of the shell, and which I have already had occasion to describe and illustrate at p. 225, and Pl. LI, fig. 15, of my ‘Monograph of British Carboniferous Brachiopoda.’ One of the specimens resembled *Spirifer concentricus*, Schnur, from the Eifel.

Sp. microgramma, Phillips (fig. 16), I have not been able to examine; and, as the very imperfect figure represents only a portion of one of the valves, it is impossible for me to offer any decided opinion as to its specific claims. I will, however, here reproduce the original description:

“*Character*.—Sub-orbicular, rather depressed, with a slight mesial undulation (convex on the lesser valve). Surface thickly and finely striated from the beaks, the striæ being crossed by the rather conspicuous edges of many laminae of growth; at the intersections of these two sets of lines are minute rounded eminences.

“The analogues of this species are fossils of the Mountain-limestone, viz., *Sp. imbricata*, *Sp. mesoloba*, &c. Having collected two agreeing specimens from different districts, I am desirous of calling attention to it, as at least a definite and delicate variety of *Sp. imbricata*. Loc.—In North Devon—Brushford; in South Devon—Hope, near Torquay.”

It must be remembered that I have already shown, at p. 64 of my ‘Carboniferous Monograph,’ that *Sp. imbricata* and *Sp. mesoloba* are synonyms, or simple modifications in shape, of *Sp. lineata*, and that we are, therefore, so far justified in provisionally locating Phillips’s so-termed species among the synonyms of Martin’s shell.

interval, as in the following scheme (the Barnstaple group being omitted, as belonging to the Carboniferous rather than to the Devonian system, or, perhaps, forming passage-beds between the two).

		CARBONIFEROUS.
DEVONIAN.	Damonian.	Petherwin beds.
		Dartmouth or Upper Slates: the “Dartmouth” group may be on the horizon of the “Petherwin” series, but it is not easy to determine this point, as the former has yielded but few fossils.
		Torquay or Limestone beds.
		Meadfoot or Lower Slate, and Upper Old Red.
	Old Red.	Middle Old Red.
		Lower Old Red.
		UPPER SILURIAN.

And that it may be true that “nobody has ever yet described any place where the South Devon beds lie above rocks which contain undoubted Upper Silurian,” and below others containing Carboniferous Limestone fossils; but that surely we must not expect to find an unbroken sequence everywhere.

SPIRIFERA SIMPLEX, *Phillips*. Pl. VI, figs. 18—22.

SPIRIFERA SIMPLEX, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 71, pl. xxix, fig. 124, 1841.

SPIRIFER — *Roemer*. Die Versteinerungen des Harzgebirges, pl. iv, fig. 11.

— — *Sandberger*. Die Brachiopoden des Rheinischen Schichtensystems in Nassau, pl. xxxii, fig. 10, 1855.

— — *Quenstedt*. Hand. der Petrefactenkunde, pl. xxxviii, fig. 22, 1851.

Spec. Char. Obtusely pyramidal, wider than long; hinge-line straight, slightly shorter than the width of the shell. Ventral valve deep, pyramidal, and longitudinally divided by a sinus, which commences at the extremity of the beak and extends to the front. Area triangular, as wide as long, and situated at a right angle to the general level of the dorsal valve; fissure narrow, arched over by a pseudo-deltidium. Dorsal valve semicircular, evenly and uniformly convex, with or without a slight elevation near the front. Surface smooth. Proportions variable.

Length 14, width 18, depth 12 lines.

Obs. This species is easily distinguishable from other British Devonian species. It occurs in the Middle Devonian limestone of Woolborough, near Newton Abbot, and has also been found in limestone near Plymouth, in Devonshire. On the Continent it occurs abundantly at Paffrath, near Cologne, in Nassau, the Hartz, &c.

Sub-genus—*SPIRIFERINA*, *D'Orbigny*.

SPIRIFERINA CRISTATA, *Schloth.* (sp.), var. Pl. VI, figs. 11—15.

TEREBRATULITES CRISTATUS, *Schlotheim*. Beitr. z. Naturg. d. Verst. in Akademie der Wissenschaften zu München, pl. i, fig. 3, 1816.

SPIRIFERA CRISTATA, *Dav.* Mon. British Permian Brachiopoda, p. 17; and Carboniferous Mon., pp. 38 and 226.

Spec. Char. Shell transversely subrhomboidal; valves almost equally convex; hinge-line as long as or slightly shorter than the width of the shell; cardinal angles acute or slightly rounded; ventral area triangular; fissure partly arched over by a pseudo-deltidium; beak incurved. The mesial fold in the dorsal valve is usually formed of a single rib, flattened along the middle, and to it corresponds a sinus in the opposite one. The remaining portion of each valve is covered with from eight to twelve angular ribs, the surface of the shell being also (in perfect specimens) intersected at close intervals by numerous

concentric laminæ of growth. Shell-structure perforated by large canals. Proportions variable; two Devonian specimens have measured:

Length 8, width 11 lines.

Obs. The question relating to the origin and recurrence of the *Spiriferina* we are at present describing is one of some difficulty, demanding considerable attention and further research. It is an exceedingly variable shell, being small (adult) in some localities or strata, while in others it has attained considerably larger dimensions. Thus, at Looe, in Cornwall, the shell is large, while at Dartington it is apparently always of small size. It is my strong impression that we must look for its first appearance or origin in the Silurian time, and that it continued to be represented, with some slight modifications, in the Devonian, Carboniferous, Permian, and perhaps up to the Jurassic period (?). One thing certain is, that, having compared some of our Scottish Carboniferous specimens, for example, with the Silurian *Anomia crispa* of Linnæus,¹ I could detect hardly any modification in shape or character. Other examples strongly resemble *Delthyris sulcata*, Hisinger, as well as some other so-termed closely related American forms. I will not, however, at present, go further into the question, but content myself by stating that our British Devonian specimens appear to be specifically the same as those we find so abundantly in the Carboniferous and Permian periods, and to which Schlotheim has applied the denomination of *cristata*, and Sowerby that of *octoplicata*. At Looe distorted internal casts are abundant; and it occurs in company with *Uncites gryphus* in the Dartington dolomitic limestone of the Middle Devonian time. Some specimens have also been found in the Pilton and Marwood beds. As we have already had occasion to observe, it is difficult to obtain from the Palæozoic limestones specimens with their outer surface perfectly preserved, and it is usually from soft shales that we must seek for examples preserving their outer sculpture; this is why the concentric laminæ which cover the surface of the shell, and which sometimes overlap each other in perfectly preserved specimens of *Sp. cristata*, and its Carboniferous and Devonian representatives, are not commonly seen; this, in addition to the variability in the number of ribs, has led to the fabrication of several so-termed species. *Sp. aculeatus*, Schnur, appears also to be very closely related to the shell under description.

¹ This is not the place, however, to enter more deeply into the question relating to the Silurian form. In his 'Ipsa Linnæi Conchylia,' by S. Hanley, 1855, we find at p. 128 the following statement:—"I cannot find a specimen in the Linnæan Cabinet to which the whole of the description will apply. The Swedes (Wahlenberg, Nilsson, Hisinger) have handed down so many of the fossil species of our author in an unbroken chain of tradition, confirmed in so many cases by the types in the collection of Linnæus, that the *Spirifer* recognized by them (*Terebrat. crispa*, Hising., 'Vet. Acad. Handl.,' 1828, pl. vii, fig. 4; *Delthyris crispa*, Dalman, 'Vet. Acad. Handl.,' 1827, pl. iii, fig. 6; Hisinger, 'Lethæa Suecica,' pl. xxiv, fig. 5) for this species of *Anomia* may be accepted as such with some degree of confidence. (Sharpe, MS.) This opinion is in harmony with that of Mr. Davidson;" but the subject will be fully discussed in our monograph of Silurian species.

? *SPIRIFERINA INSCULPTA*, *Phillips* (sp.), var. Pl. VI, figs. 16, 17.

SPIRIFERA INSCULPTA, *Phillips*. Geol. of Yorkshire, vol. ii, p. 216, pl. ix, figs. 2 and 3, 1836.

SPIRIFERINA — *Dav.* British Carb. Brachiopoda, p. 42, pl. vii, figs. 48—55, and pl. lii, figs. 14, 15.

Spec. Char. Shell somewhat pentagonal, wider than long; hinge-line straight, and usually slightly shorter than the width of the shell; cardinal angles rounded; area triangular and slightly curved. Dorsal valve moderately convex, with from five to seven strong angular ribs, of which the central one is the largest. Ventral valve slightly deeper than the opposite one, with from four to six strong angular ribs, divided by a sinus of greater depth; beak incurved; fissure partly arched over by a pseudo-deltidium. Surface of the shell closely and regularly intersected by numerous concentric laminæ of growth. Shell-structure perforated.

Length 7, width 8, depth 5 lines.

Obs. It is possible that the shell under description may be nothing more than a modification of *Sp. cristata*, with fewer and stronger ribs. It bears also some resemblance to certain examples of *Spiriferina crispa*, but more so to the Carboniferous *Sp. insculpta*, with which it is, at any rate, provisionally identified.

It occurs in the Middle Devonian limestone of Lammaton, near Torquay.

Spiriferina laminosa, M'Coy, has been stated by Mr. Salter to occur in the Marwood beds of North Devon; but I have not been fortunate enough to procure examples.

Genus—CYRTINA, *Dav.*

CYRTINA HETEROCLITA, *DeFrance*, (sp.)¹ Pl. 9, figs. 1—16.

CALCEOLA HETEROCLITA, *Defr.* Dic. Sc. Nat., vol. lxxx, fig. 3, et *De Blainville*, Malacologie, pl. lvi, fig. 3.

SPIRIFER HETEROCLYTUS, *Buch.* Ueber Delthyris oder Spirifer und Orthis, p. 40, 1837; and Mém. Soc. Géol. de France, vol. iv, p. 186, pl. viii, fig. 11, 1840.

— HETEROCLITA, *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 72, pl. xxix, fig. 125, 1841.

— SUBCONICA, var. *Sowerby* (not of *Martin*). Trans. Geol. Soc., 2 ser., vol. v, pl. lvii, fig. 10.

SPIRIFERA (CYRTIA) HETEROCLITA, *M'Coy*. British Pal. Foss., p. 377, 1852.

¹ Some palæontologists have spelt the term *Heteroclitus* with a *y* (*Heteroclytus*), but the first is the correct spelling. *Heteroclitus* means originally a verb irregularly declined; in Greek, ἑτερόκλιτος, with the *κ* short.

SPIRIFER HETEROCLITUS, *Quenstedt*. Handbuch der Petrefactenkunde, pl. xxxviii, fig. 21, 1851.

— — — *Davidson*. General Introduction, pl. vi, figs. 63, 64, 1853.

— — — *Schnur*, in Dunk. u. Von Meyer's Palæontograph., vol. iii, pl. xxxv, fig. 6, 1853.

— — — *Sandberger*. Die Brachiopoden des Rheinischen Schichtensystems in Nassau, pl. xxxii, fig. 8, 1855.

CYRTINA HETEROCLITA, *Dav.* Mon. Carb. Brach., p. 67, 1858.

Spec. Char. General shape acutely pyramidal; hinge-line as long as, or a little shorter than, the width of the shell. Ventral valve pyramidal, and much deeper than the opposite one; area flat, triangular, very large, and bent back at various angles to the general surface of the dorsal valve; fissure long, narrow, and almost entirely arched over by a pseudo-deltidium; sinus deep, angular, extending from the extremity of the beak to the front. Dorsal valve semicircular, with a prominent, more or less angular, fold. Each valve is ornamented with from six to sixteen or more angular ribs. In the interior of the ventral valve two contiguous vertical septa coalesce into one median plate, which extends from the extremity of the beak to within a short distance of the frontal margin, and then diverges to form the dental plates, in a very similar manner to what we perceive in Pentamerus. The median septum is continued as far as the under surface of the deltidium, although this is not always seen in our specimens. Shell-structure punctated. Proportions very variable:

Length 5, width 7, depth 10 lines.

Obs. This important and characteristic fossil of the Middle Devonian limestones of Great Britain and the Continent is exceedingly variable in shape, this being chiefly occasioned by the greater or lesser development of the area, and of the number of ribs with which the surface of the shell is ornamented. In some specimens the beak is also twisted to one side or the other. It is a small species, but some French specimens have attained twice the dimensions of any hitherto found in this country. In Devonshire it occurs in Upper Devonian limestone, near Plymouth; at Barton and Lummaton, near Torquay; Woolborough, near Newton Abbott; Dartington, near Totness, and in coarse limestone at Hagginton Hill, near Ilfracombe, North Devon. On the Continent it is found at Ferques, in the Boulonnais (France); Chimay (Belgium); the Eifel, in Nassau, &c.

Var. MULTIPLICATA, Dav. Pl. IX, figs. 11—14.

SPIRIFERA CUSPIDATA, *Phillips* (not of *Sow.*). Pal. Foss. of Cornwall, Devon, and West Somerset, p. 72, pl. xxix, fig. 124^B.

Spec. Char. Shell transverse, wider than long; lateral margins forming attenuated acute angles with the extremities of the hinge-line or area; dorsal valve semicircular,

moderately convex, with a prominent angular fold; ventral valve pyramidal, deeper than the opposite one; sinus angular, commencing at the extremity of the beak and extending to the front; area large, flat, triangular; fissure narrow, entirely arched over by a pseudo-deltidium. Each valve is ornamented by from twelve to twenty small angular ribs, the surface being likewise traversed by numerous concentric lines of growth.

Length 4, width 8, depth 5 lines.

Obs. I am much puzzled how to deal with this shell, for although closely connected to, and probably nothing more than a modification in shape or variety of, *Cyrtina heteroclita*, it presents certain differences which might lead one to imagine it almost a distinct species. Indeed, Phillips has described and figured it as a small form of the Carboniferous *Spirifera cuspidata*; but from this it is not only specifically but also generically distinct, for its internal dispositions agree with those we have already described for *Cyrtina heteroclita*. Some specimens also appear to connect this variety with the typical forms of the species.

It may, therefore, be better to provisionally consider it a variety of *C. heteroclita*, with the distinctive denomination of "*multiplicata*;" and I have figured a series of specimens which will enable the reader to determine the question as he may think proper. The variety here described has been found at Barton and Lummaton, near Torquay.

CYRTINA DEMARLII, *Bouchard*, MS. Pl. IX, figs. 15—17.

SPIRIFERA SUBCONICA, *Phillips* (not of *Martin* nor *Sowerby*). Pal. Foss. of Cornwall, Devon, and West Somerset, p. 72, pl. xxix, fig. 126, 1841.

Spec. Char. Shell small, wider than long; hinge-line about as wide as the shell; dorsal valve semicircular, moderately convex; ventral valve pyramidal, much deeper than the opposite one, with a sinus of moderate depth, to which corresponds a biplicated mesial fold in the opposite one; about twelve simple ribs ornament the lateral portions of each valve; area large, triangular, situated at right angles to the general plane of the dorsal valve; fissure narrow, arched over by a pseudo-deltidium; shell-structure punctated.

Length 3, width 4, depth 3 lines. Some specimens attained somewhat larger proportions.

Obs. The longitudinal groove in the centre of the mesial fold serves to distinguish this shell from *C. heteroclita*. The interior arrangements appear to be similar to those of the last-named species, the median septum in the ventral valve being continued as far as the under surface of the deltidium, while the dental converging plates are fixed to its sides. Mr. Lee found two specimens of this small shell in the Middle Devonian Limestone of Barton, near Torquay; and it has been often collected by Mr. Bouchard and by myself at Ferques (France).

CYRTINA ? AMBLYGONA, *Phillips* (sp.). Pl. IX, figs. 18—20.

TEREBRATULA AMBLYGONA, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 88, pl. xxxv, fig. 160, 1841.

Spec. Char. Shell oblong, somewhat pentahedral, nearly as wide as long; hinge-line rather shorter than the width of the shell; dorsal valve slightly convex; mesial fold rather flat, of small elevation, originally with one narrow rib, but gradually widening and forming two additional ribs by bifurcation, or by the juxtaposition of a lateral rib; eight or ten other simple ribs ornament the surface of the valve; ventral valve convex, deeper than the opposite one; sinus shallow, rather flat, and composed of two ribs at its origin, but these bifurcate at a short distance from the extremity of the beak; the area is triangular, rather large; fissure narrow, arched over by a pseudo-deltidium. Two specimens have measured:

Length 7, width 6, depth 3 lines.

„ 5, „ 7, „ 4 „

Obs. Having procured from Mr. Lee the loan of the figured type, and removed the matrix which obscured the beak and a portion of the surface of the dorsal valve, I soon perceived that the shell belonged either to *Spirifera* or *Cyrtina*, and not to *Terebratula*, as had been supposed by Phillips. Not having been able to examine its interior arrangements, I am uncertain whether it should be classed under *Spirifera* or *Cyrtina*, and have therefore left it provisionally with the last-named sub-genus. Two specimens were found by Mr. Lee in the Middle Devonian Limestone of Barton, and I have another from Lummaton, near Torquay.

Genus—ATRYPA, *Dalman*, vel SPIRIGERINA, *D'Orbigny*.

ATRYPA LENS, *Phillips* (sp.). Pl. X, fig. 1.

ORTHIS LENS, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 65, pl. xxvi, fig. 110^{a, b}, 1841.

TEREBRATULA DIVIDUA, *Schnur*. Programm der vereinigten höhern bürger und provinzial Gewerbeschule zu Trier, p. 6, 1851, and in Dunker und Von Meyer's Palæontographica, vol. iii, p. 179, pl. xxiv, fig. 2, 1853.

ORTHIS LENS, *D'Archiac* and *De Verneuil*. Description of the Older Deposits of the Rhenish Provinces, Trans. Geol. Soc., 2d series, vol. vi, p. 396.

— — *Morris*. Catalogue of British Fossils, p. 140, 1854.

ORTHIS EIFLIENSIS, *J. Steininger*. Geognostische Beschreibung der Eifel, p. 80, pl. v, fig. 5, 1853.

Spec. Char. Shell small, compressed, longitudinally oval, notched in front; valves almost equally deep, very slightly convex, with a longitudinal sulcus or groove along the centre of each valve, but usually deeper in the dorsal one; surface ornamented with from

twenty-two to twenty-four small, rounded, radiating ribs, of which a few are sometimes bifurcated, with interspaces of almost equal breadth between them. The two or three ribs which occupy the median groove are usually smaller than those which ornament the lateral portions of the valves, the whole being crossed by numerous concentric lines of growth. Beak of the ventral valve small, slightly incurved, and with a minute, circular aperture under its angular extremity; a small, flattened space existing, likewise, between the beak-ridges and the hinge-line. Proportions variable:

Length 6, width $5\frac{1}{2}$, depth $1\frac{1}{2}$ lines.

Obs. This little shell, characteristic of the Middle Devonian beds of England and of the Continent, was first discovered at Hope's Nose, near Torquay, and described by Phillips as an *Orthis*. Subsequently, it was found by Professor Schnur in beds of a similar age at Prüm and Gerolstein, in the Eifel, where the shell appears not to be very uncommon. Professor Schnur, however, gave to the Prussian specimen a new name, *Terebratula dividua*, and figured at the same time a portion of the interior, to show two vertically and spirally coiled lamellæ, of which the extremities are directed towards the bottom of the dorsal valve. This species is, therefore, not an *Orthis*, as was supposed by Phillips, De Verneuil, and others, nor a *Chonetes sarcinulata*, as hinted by Professor Morris, nor a *Terebratula*, as supposed by Schnur, but should find place in Dalman's genus *Atrypa*, or *Spirigerina* of D'Orbigny.

The *Atrypa lens* of Sowerby (Pl. 21, fig. 3, of Murchison's 'Silurian System') belongs to the genus *Pentamerus*.

The careful examination I have made of the original types now preserved in the Museum of the Geological Survey, as well as of some others found likewise at Hope's Nose by Mr. Champernowne, and of a numerous suite of specimens sent to me from the Eifel by Professor Schnur, leaves no uncertainty in the determination of this interesting little species, or of its identity with *Terebratula dividua* of the last-named author.

ATRYPA LEPIDA, Goldfuss (sp.). Pl. X, fig. 2.

TEREBRATULA LEPIDA, D'Archiac and De Verneuil. Description of the Fossils of the Older Deposits of the Rhenish Provinces, Trans. of the Geol. Soc., 2nd series, vol. vi, p. 368, pl. xxxv, fig. 2.

— — A. Roemer. Die Versteinerungen des Harzgebirges, pl. xii, fig. 22, 1843.

SPIRIGERINA — D'Orbigny. Prodrome de Paléontologie Stratigraphique, vol. i, p. 100, 1849.

TEREBRATULA — Schnur, in Dunker und Von Meyer's Palæontographica, vol. iii, p. 180, tab. xxiv, fig. 1, 1853.

Spec. Char. Shell very small, longitudinally oval, or circular; ventral valve ventricose, convex, and deep, with a shallow median groove and three feebly projecting rounded ribs on each side of the lateral portions of the valve; beak exceedingly small,

angular; foramen minute, a small flattened space existing between the beak-ridges and the hinge-line; dorsal valve elliptical and flattened, with a wide, shallow, median depression, or sinus, extending from the umbone to the front, while a small longitudinal rib occupies the centre, the sinus being limited on each side by a rounded rib. The surface of each valve is closely and regularly intersected by numerous squamose concentric laminæ.

Length 4, width 4, depth 2 lines.

Obs. I was glad to recognise a specimen of this interesting little species in the collection of the Rev. J. E. Lee, who had found it in the Middle Devonian Limestone of Barton, near Torquay, where the shell appears to be rare. It does not appear to have attained much larger proportions than those above given. It is stated to be also rather uncommon in the Eifel, from whence, however, I have obtained about a dozen specimens. It has been beautifully figured by M. De Verneuil and Professor Schnur. Viscount D'Archiac and M. De Verneuil have likewise observed that "its form would bring this species into *Atrypa* of Dalman, if that genus could be preserved in a scientific classification, which they think it cannot." My learned friends were, however, mistaken in this last supposition, for whether the shells in question be termed *Atrypa* or *Spiriferina*, the genus is among the best we have in the classification; and under no circumstance could the shell be considered a *Terebratula*. Although we have never seen the interior dispositions, I think that the shell must have been provided with spiral appendages similarly disposed to those figured by Schnur in *Atrypa lens*.

A. lepida occurs at Prüm, Gerolstein, &c., in the Eifel; and has also been found in the Hartz.

ATRYPA RETICULARIS, *Linnæus* (sp.). Pl. X, figs. 3, 4.

ANOMIA RETICULARIS, *Linnæus*. Syst. Nat., ed. xii, p. 1132, 1767.

TEREBRATULÆ PECTINATÆ, T. SUBTILISSIME STRIATÆ, T. CANCELLATÆ, T. MINUTISSIME STRIATÆ, *Schröter*. Abhandlungen über verschiedene Gegenstände der Naturgeschichte, pl. iii, figs. 11—18, and pl. iv, figs. 19—26, 1777.

TEREBRATULA PECTINATA, *Bruguière*. Hist. Nat. Vers.; Testacés, Encyclopédie Méthodique, pl. 242, pl. iv, 1789.

ANOMITES RETICULARIS, *Wahlenberg*. Nov. Act. Soc. Upsal., vol. viii, figs. 65, 66, 1821.

TEREBRATULA AFFINIS, *Sowerby*. Min. Con., tab. 324, fig. 2, Jan., 1822.

SPIRIFER SOWERBYI, *Def.* Dict., vol. 1, p. 295, t. lxxvi, fig. 2 (valva brachiis spiralibus ornata).

TEREBRATULA (MAGAS) CANCELLATA, *Eichw.*, Zool., i, 276, tab. iv, fig. 11.

TEREBRATULITES PRISCUS, *Schlotheim*. Nachträgen zur Petrefactenkunde, pl. xvii, fig. 2, 1822.

— EXPLANATUS, *Schloth.* Ibid., pl. xviii, fig. 2.

ATRYPA RETICULARIS, *Dalman*. Vet. Ac. Handl., pl. iv, fig. 2, 1827; *Hisinger*, Lethæa Suecica, pl. xxi, fig. 11.

TEREBRATULA PRISCA, *Buch*. Ueber Terebrateln, p. 71, 1834.

- ATRYPA AFFINIS*, *Sowerby*, in Murchison's 'Silurian System,' pl. vi, fig. 5, 1839.
DELTHYRIS PRISCA, *Fahrenb.*, in Bull. Mosc., p. 788, 1844.
TEREBRATULA (ATRYPA) PRISCA, *Phill.* Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 81, pl. xxxiii, fig. 144, 1841.
 — *INSPERATA*, *Phillips*. Ibid., p. 83, pl. xxxiii, fig. 17, 1841.
SPIRIFER AFFINIS, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvii, fig. 11.
TEREBRATULA PRISCA, *D'Archiac* and *De Verneuil*. Trans. Geol. Soc., 2nd series, vol. vi, p. 392.
 — *PRISCA*, *A. Roemer*. Die Versteinerungen des Harzgebirges, pl. v, figs. 11—13, 1843.
 — *RETICULARIS*, *De Verneuil*. Geol. of Russia and the Ural Mount., vol. ii, pl. x, fig. 12, 1845.
ATRYPA LENTIFORMIS, *Vanuxem*; and *A. AFFINIS*, *Hall*. Geology of the State of New York, 1846.
TEREBRATULA RETICULARIS, *Barrande*. Ueber die Brachiopoden Silurischen Schichten von Boehmen, pl. xix, fig. 8, 1847.
 — — *Bronn*. Index Palæontologicus, p. 1248, 1848.
SPIRIFERINA — *D'Orbigny*. Prodrome, vol. i, p. 99, 1849.
TEREBRATULA PRISCA, *Quenstedt*. Handbuch der Petrefactenkunde, p. 461, tab. xxxvii, figs. 1—4, 1851.
ATRYPA RETICULARIS, *Davidson*. British Fossil Brachiopoda, Introduction, vol. i, pl. vii, figs. 87—93, 1853.
TEREBRATULA INSQUAMOSA, *Schnur*. Dunker und Meyer's Palæontographica, vol. iii, p. 181, fig. 4, 1853.
ATRYPA RETICULARIS, *Morris*. A Catalogue of British Fossils, p. 132, 1854.
ANOMIA — *Sharpe*, in Hanley's 'Ipsa Linnæa Conchylia,' p. 127, 1855.
SPIRIGERINA — *M'Coy*. British Palæozoic Fossils, p. 379, 1852.
 — — *Sandberger*. Die Brachiopoden des Rheinischen Schichtensystems in Nassau, p. 51, pl. xxxiii, fig. 1, 1851.
ATRYPA — *Woodward*. A Manual of the Mollusca, p. 228, figs. 144, 145, and pl. xv, fig. 21, 1856.
 — — *J. Hall*. Report on the Geological Survey of the State of Iowa, pl. vi, figs. 4 and 5, 1858.
 — — *Hall*. Natural Hist. of New York, Palæontology, vol. iii, p. 253, pl. xlii, fig. 1, 1862.

(Many more references could be added, but the list above given contains the most important.)

Spec. Char. Shell oblong ovate, widest near the hinge; beak small, acute, very little produced, incurved, and often pressed to the umbone of the ventral valve, so that the small circular foramen, situated under its incurved extremity, is rarely perceptible. Dorsal valve uniformly convex, at times gibbous, and without any defined fold, but becoming slightly concave towards the cardinal extremity or on either side of the umbone. Ventral valve much less convex and deep than the opposite one, convex at the beak and along the middle, but becoming gently concave towards the lateral portions or margins of the valve; front margin a

little advanced, indenting that of the dorsal one. Surface of valves ornamented with numerous small, radiating, rounded ribs, which continually augment towards the margin by the means of bifurcation, or by the intercalation of ribs at various distances from the beaks. The surface is also closely intersected or crossed by numerous foliaceous expansions, in the shape of plaited laminae or frills. Shell-structure fibrous and impunctate. Spiral appendages, originating at the base of the socket-walls, form two large hollow cones placed horizontally, with their apices directed inwards and towards the hollow of the same (dorsal) valve, which they almost fill; the inner sides of the spires are pressed together and flattened, and with their terminations close to each other near the centre of the bottom of the shell (Pl. xi., figs. 7, 8). In the interior of the dorsal valve the quadruple impressions of the adductor muscle are separated by a medio-longitudinal ridge, the pedicle or dorsal adjustor muscles being probably fixed to the two small cardinal plates. In the ventral valve, at the base of the teeth a semicircular ridge curves on each side, forming a saucer-shaped depression, open in front, and into which the muscles were fixed (Pl. xi., fig. 9); the divaricator muscles seem to occupy the largest portion of the depression, and to have been divided by an obscure mesial ridge; beyond these, and at a little higher up, are placed the pedicle muscular impressions, and above the mesial ridge, nearer the beak, is seen the oval scar left by the adductor. The vascular impressions on the dorsal valve consist of two principal trunks, originating on each side between the cardinal and pedicle muscles; these soon divide into two primary branches, which extend right and left almost parallel to the margin, giving off at various intervals smaller bifurcating veins, which are directed towards the edge of the shell. Proportions very variable:

Length 2 inches 5 lines, width 2 inches 2 lines, depth 1 inch 2 lines; but the shell has usually smaller dimensions.

Obs. At page 127 of Hanley's '*Ipsa Linnæa Conchylia*' we find the following remarks:—" *Anomia reticularis*. In the Linnean collection are several specimens of this fossil, which alone of those present—and its presence in his cabinet has been recorded by our author—answers to the description in the '*Systema*.' The species, which is well known, and is found very abundantly in all the beds from the Devonian to nearly the bottom of the Silurian system, has received the following appellations:

" *ANOMITES RETICULARIS*, *Wahlenberg*, '*Nov. Act. Soc. Upsal.*' vol. viii, p. 65.

" *TEREBRATULITES PRISCUS*, *Schlotheim*, '*Petrefact.*' pl. lxxxvii, fig. 9.

" *TEREBRATULA AFFINIS*, *Sowerby*, '*Min. Conc.*' pl. 324, fig. 2.

" &c., &c.

"The name of *reticularis*, being traced back to Linnæus, must henceforth be adopted to the exclusion of the many others it has received. (Sharpe, MS.)"

In this statement I am fully prepared to coincide, having also carefully studied the Linnean specimens in company with MM. Bouchard and Salter.

It is a most variable shell, and has, consequently, been shifted about from genus to

genus, and has received a great number of different specific denominations. In 1777, several of its varieties were well figured by Schröter, and who, while describing them, did apply to each modification in shape distinctive denominations, such as *pectinata*, *subtilissime striata*, *cancellata*, *minutissime striata*, &c. The width and number of the striæ, as well as of the concentric laminæ, constitute the principal differences observable in specimens of this important and curious species. All these modifications can be traced in specimens from any single locality, as is the case at Ferques, in the Boulonnais, France, as well as at Refrath, near Cologne, in Prussia, where the shell is exceedingly abundant. The beak is usually so closely pressed to the umbone of the dorsal valve, that no foraminal aperture can be perceived; and this led Dalman, the founder of the genus *Atrypa*, to suppose that the beak was *imperforate*. In some examples, however, of *A. reticularis* the foramen can be perceived: consequently Dalman's term becomes a zoological misnomer, and D'Orbigny's *Spirigerina* would be a preferable substitute. The identity of the Silurian and Devonian specimens have likewise been recognised by several distinguished observers. Thus, at page 297 of the second edition of Murchison's 'Siluria,' we find—"Among the Mollusca nearly all the species of *Atrypa*, *Orthis*, and *Spirifer*, differ from those of the Silurian era. One shell, however, the *Atrypa reticularis*, must be mentioned as an exception to the prevalent rule of each great group being distinguished by peculiar forms; for this hardy species, with which the reader became so familiar in the Silurian rocks, lived on to the Devonian era, and is as common in the limestones and shale of Devonshire as in the older series. It even ranges to the furthest known geographical limits of the Devonian rocks, to Armenia, the Caucasus, and China on the east, and to the Devonian deposits of America on the west!" And again, at page 379 of the work on 'British Palæozoic Fossils,' Professor M'Coy observes, while treating of *Spirigerina reticularis*, that he cannot perceive the slightest difference between some of the Eifel and Upper Silurian and some of our Devonshire specimens.

Atrypa reticularis occurs abundantly in the Middle Devonian Limestones of Barton, Lummaton, and Hope's Nose, near Torquay. In limestone of a similar age at Dartington and Black Hall, near Totness; near Plymouth; at Woolborough and Oghwell, near Newton Abbot; Chircombe Bridge, near West Oghwell; and Hagginton Hill, near Ilfracombe, &c., in Devonshire. In Cornwall it occurs at Looe; and, according to Mr. Salter, in the Upper Devonian beds of Petherwin and Landlabe (?).

On the Continent it abounds at Ferques, Chimay, Couvin, Hay; in the Eifel; at Paffrath, Refrath, Lustheide, Hübigenstein (Hartz), Lake Ilmen, Volkof, Voronege, &c.; also in the Ural, Smeinogorsk (Altai); State of Ohio, New York, Tennessee, &c., &c.

Some modifications (?) of this species may be worthy of varietal denominations.

PLATE I.

DEVONIAN SPECIES.

FIG.

- 1—8. ? *Terebratula Sacculus*, Martin, varr. Several modifications in shape. From the Middle Devonian Limestone of Barton and Lummaton, near Torquay, Devon.
9. „ *elongata*, Schl. ? Upper Devonian ? Brown grits of East Hill, Braunton, Devonshire.
- 10—15. „ *juvenis*, Sow. Different specimens from the Middle Devonian Limestone of Barton and Lummaton. Fig. 13, Sowerby's type ; Plymouth. Mus. Geol. Soc.
- 16, 17. „ *Newtoniensis*, Dav. Middle Devonian, Woolborough Quarry, near Newton Abbot. Fig. 16, Collection of Mr. Champernowne. Fig. 17, Mr. Vicary's Collection.
18. *Stringocephalus Burtini*. Def. Middle Devonian, Bradley, near Newton. Mus. Geol. Soc.
- 19, 20. „ „ „ = *Terebratula porrecta*, Sow. After the original figures, Min. Conch., tab. 576, fig. 1. Bradley, near Newton.
21. „ „ „ A circular, and unusual shape ; Chircombe Bridge, Devonshire. Mus. of Geol. Survey. A similar specimen is represented in p. 294, fig. 4, of the second edition of 'Siluria,' but there named *St. giganteus*.
22. „ „ „ = *St. giganteus*, Sow. A large distorted example, from the Middle Devonian Limestone, near Plymouth, and of which a reduced figure is given by Sowerby in the 'Trans. Geol. Soc.,' vol. v, 2d series, pl. lvi, fig. 11.

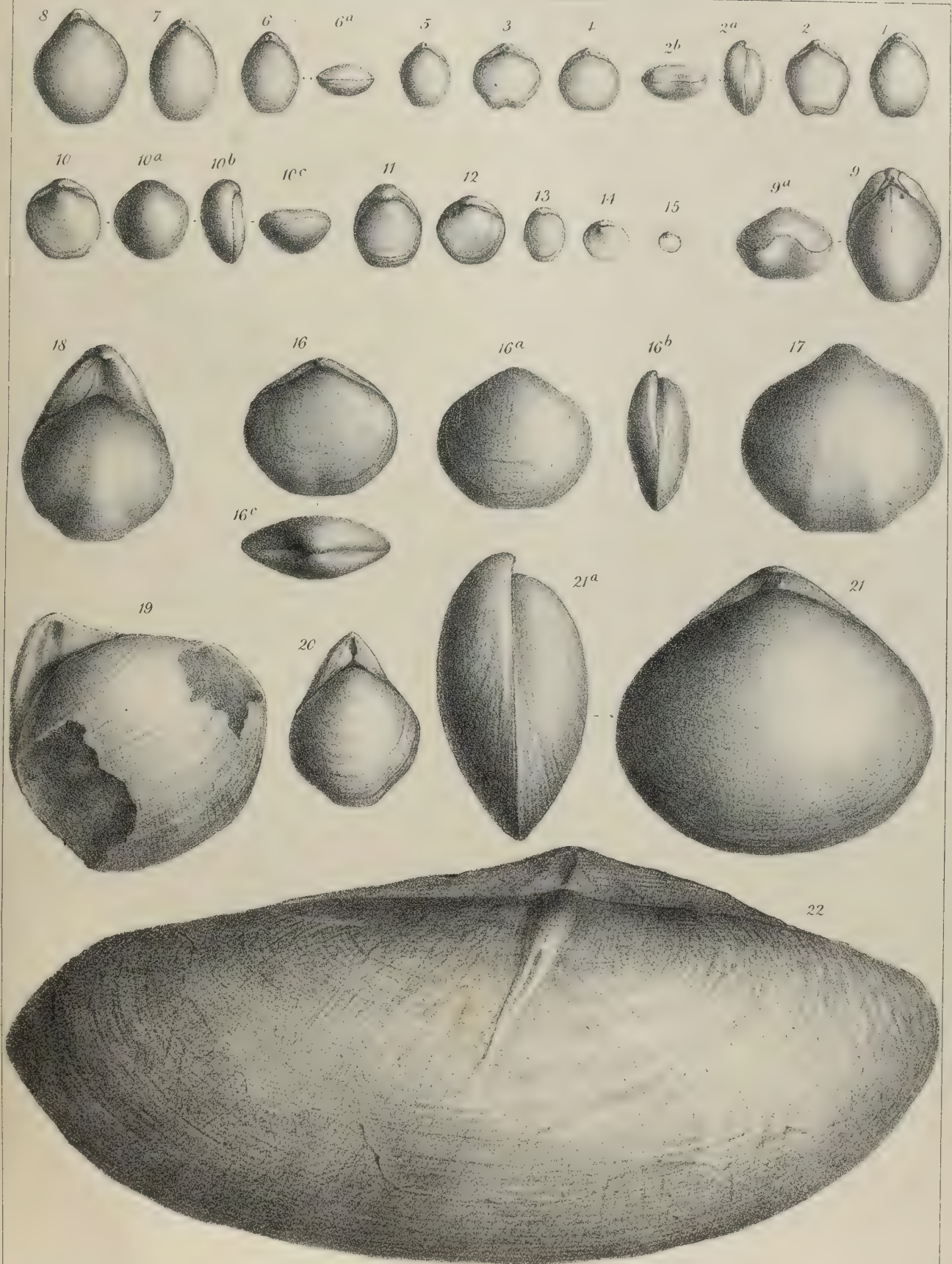


PLATE II.

DEVONIAN SPECIES.

FIG.

- 1—5. *Stringocephalus Burtini*, Def. Young shells. Middle Devonian, Bradley, near Newton. Museum of the Geological Society.
6. ,, ,, From Woolborough Quarry, near Newton Abbot. Collection of Mr. Walton.
7. ,, ,, = *St. giganteus*, Sow. After Phillips' 'Pal. Foss. of Cornwall, Devon, and West Somerset,' pl. xxxii, fig. 142.
8. ,, ,, = *St. giganteus*. A very large, distorted, flattened specimen. From near Plymouth. Mus. Geol. Soc.
9. ,, ,, = *Uncites laevis*, M'Coy. After M'Coy, 'British Pal. Fossils,' pl. 2^A, fig. 6. From near Newton. Cambridge Museum.
- 10, 11. ,, ,, Specimens showing the internal dispositions of the loop, &c.; reduced figures after the originals by Prof. E. Suess.

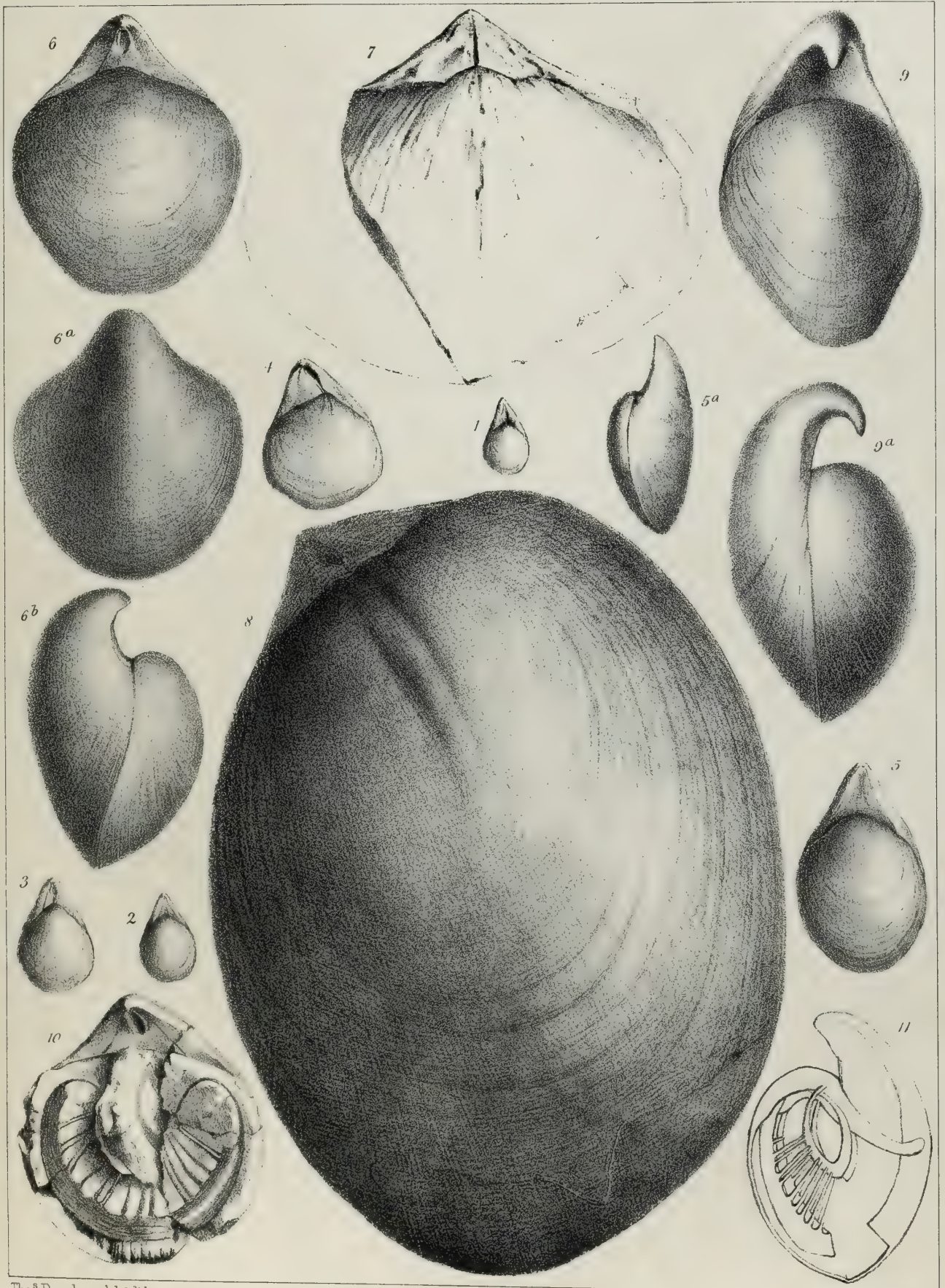
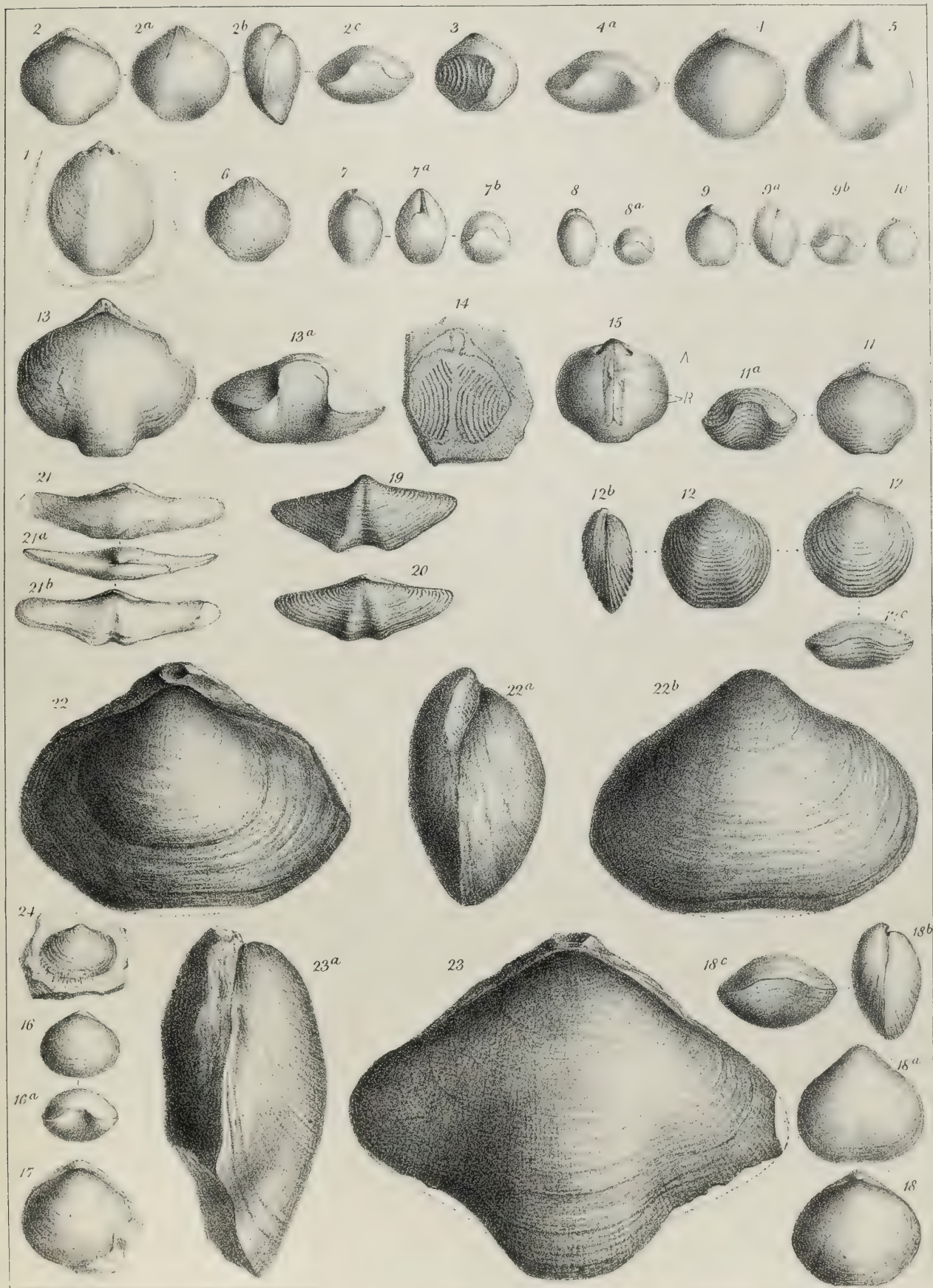


PLATE III.

DEVONIAN SPECIES.

FIG.

1. *Athyris* ? — *Atrypa oblonga*, Sow., 'Trans. Geol. Soc.,' 2nd series, vol. v, tab. xxxvi, fig. 6, Upper Devonian?, Barnstaple. Mus. Geol. Soc. Stated by Professor M'Coy to be a crushed internal cast of *Athyris concentrica*.
- 2—8. *Merista plebeia*, Sow. sp. = *Sp. scalprum*, Roemer. Fig. 2, from Sowerby's type, Mount Wise, near Plymouth. Mus. Geol. Soc. Fig. 4 from north side of Stone House Hill, near Plymouth. Plymouth Inst. Mus. Figs. 3, 5, 6, 7 from near Newton Abbot and Torquay; fig. 5 shows the peculiar fissure produced by a portion of the matrix having dropped out where the "shoe-lifter-shaped process" existed.
- 9, 10. ,, ,, = *Atrypa lacryma*, Sow., 'Geol. Trans.,' 2nd series, vol. v, tab. xxxvi, fig. 9. These drawings are made from Sowerby's original specimens, in the Mus. Geol. Soc., from the Middle Devonian Limestone of Stone House Hill, near Plymouth.
- 11, 12. *Athyris concentrica*, var. Fig. 11, Upper Devonian, East Petherwin, Cornwall. Fig. 12, from Hope's Nose, near Torquay. Collection of Mr. Pengelly.
- 13, 14. ,, ,, Von Buch. Typical shape, from the shale at Mudstone Bay, South of Berry Head, Devonshire. Collection of Mr. Pengelly.
15. ,, ,, Internal cast, showing the muscular impressions, from the Upper Devonian, Pilton Beds, Orchard Quarry, 1 mile north of Barum, North Devon. Collection of Mr. J. M. Hall.
16. ,, ? ,, = *Atrypa indentata*, Sow., 'Geol. Trans.,' 2nd series, vol. v, pl. liv, fig. 6. Petherwin, Cornwall. After the original figure.
17. ,, ? ,, = *Atrypa decussata*, Sow., 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liv, fig. 5. Petherwin. After the original figure.
18. ,, ? ,, Perhaps the same as *A. decussata*, near Newton Abbot. Collection of Mr. Vicary.
19. *Athyris phalæna*, Phillips. The original specimens from shale at Hope's Nose, near Torquay. Mus. Geol. Survey.
20. ,, ,, = *A. hirundo*, Phillips. From the original example, Hope's Nose, near Torquay. Mus. Geol. Survey.
22. *Athyris Newtoniensis*, Dav. Middle Devonian, Woolborough Quarry, near Newton Abbot. Collection of Mr. Champenowne.
23. ,, *Bartoniensis*, Dav. Barton, near Torquay. Collection of Mr. Lee.
24. ,, *concentrica* ? = *A. hispida*, Sow., 'Trans. Geol. Soc.,' vol. v, 2nd series, pl. liv, fig. 4, Petherwin, Cornwall.



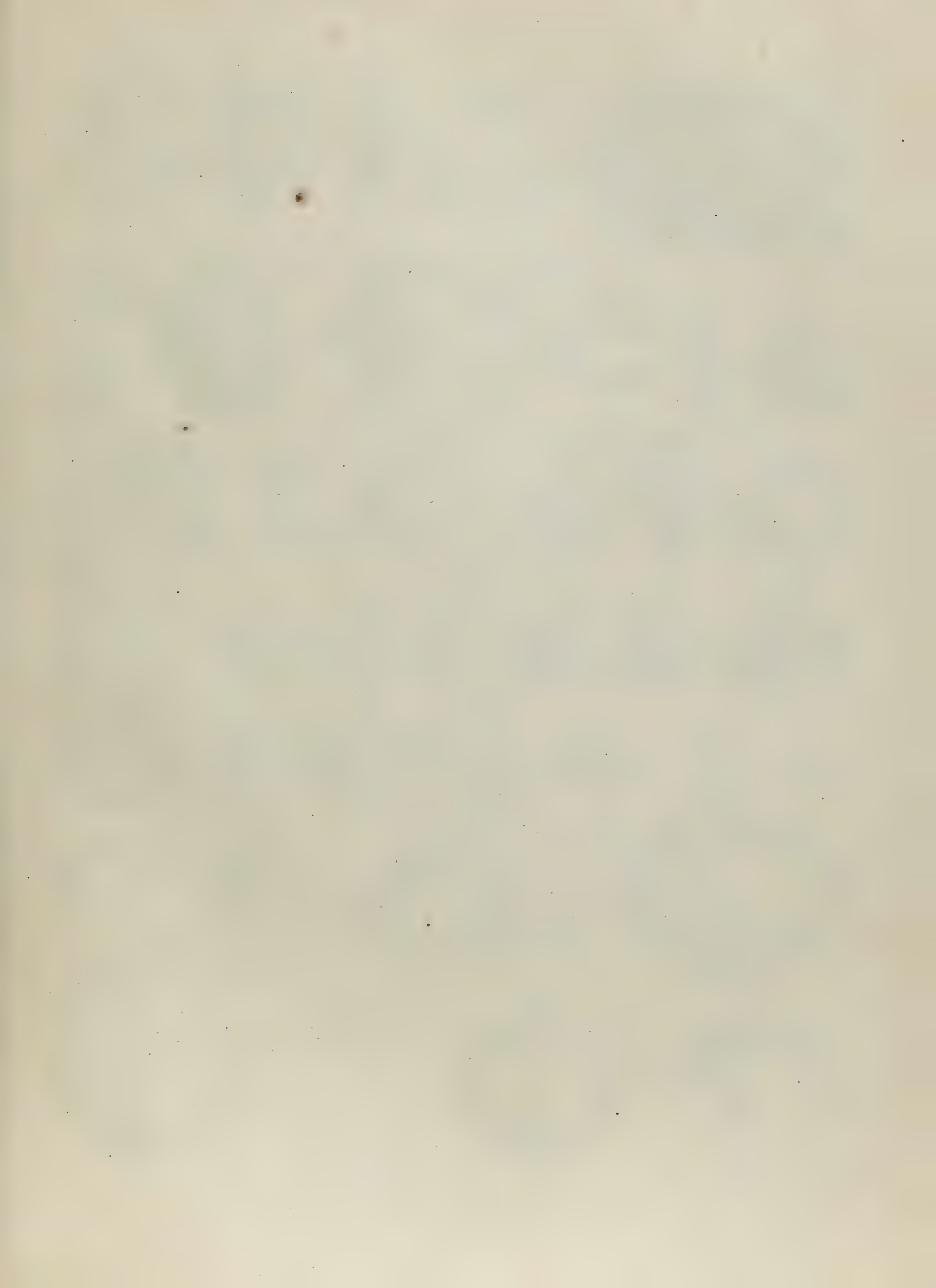


PLATE IV.

DEVONIAN SPECIES.

FIG.

- 1—3. *Athyris*, sp.? Supposed to belong to *A. concentrica*. Casts and impressions from brown grit, Upper Devonian of Incedon, near Barnstaple and Braunton.
4. „ ? Internal cast of an undetermined species, from the light brown grits, Looe, Cornwall. Collection of Mr. Pengelly.
- 5—7. *Rensselæria stringiceps*? F. Roemer. Casts, Devonian Limestone, Hagginton Hill. Collection of Mr. Valpy.
- 8—10. *Retzia ferita*, Von Buch. Fig. 8, Woolborough Quarry, near Newton Abbot. British Museum. Fig. 9, Barton, near Torquay. Collection of Mr. Lee. Fig. 10, Mus. of the Geol. Survey.
- 11, 12. *Uncites gryphus*, Defr. From the Dartington dolomitic limestone, near Totness, and Middle Devonian Limestone, Woolborough Quarry, near Newton Abbot.
13. *Spirifera lineata*? Martin. Middle Devonian, Woolborough Quarry, near Newton Abbot. Collection of Mr. Pengelly.
- 14, 15. „ „ after Phillips, 'Pal. Foss. of Cornwall, Devon, and West Somerset,' t. xxviii, fig. 120, Upper Devonian, Petherwin and Landlake. [Never having seen these specimens, I am unable to affirm their identity with the Carboniferous *Sp. lineata*.]
16. „ „ = *Sp. microgemma*, Phil., 'Pal. Foss.,' pl. xxvii, fig. 116, Not having seen this specimen, I here introduce it upon Professor Phillips' authority. Hope's Nose, near Torquay.
- 17—22. *Spirifera nuda*, Sow. Middle Devonian. Fig. 17, Barton, near Torquay. Sharpe Collection, Mus. Geol. Soc. Fig. 18, original type, Dockyard, near Plymouth. Mus. Geol. Soc. Figs. 19, 20, Woolborough, near Newton Abbot. Fig. 21, Dartington, near Totness, Devon. Collection of Mr. Champernowne. Fig. 22, Barton. Collection of Mr. Lee.
- 23, 24. „ „ = *Sp. pulchellus*, Sow., 'Trans. Geol. Soc.,' vol. v, 2nd ser., tab. lvii, fig. 9, Middle Devonian Limestone, Mount Wise, near Plymouth. Mus. Geol. Soc.
- 25—28. „ *Urii*, Flem. = *Sp. unguiculus*, J. Sow., in brown grits, Upper Devonian of Bradford, near Barum, North Devon; and South Petherwin, Cornwall. Fig. 26, original figure in 'Geol. Trans.,' 2nd series, vol. v, pl. liv, fig. 8.
- 29—32. „ *curvata*, Schloth. Decorticated examples. Fig. 29, Barton, near Torquay. Sharpe's collection, Mus. Geol. Soc. Fig. 30, Lummaton, near Torquay. Fig. 31, Chircombe Bridge, near Newton. Collection of Mr. Vicary. Fig. 32, near Torquay. (See more perfect examples, pl. ix, figs. 22, 26, & 27.)
33. „ ? Internal flattened cast, Devonian, Looe, Cornwall.
34. „ ? Woolborough Quarry, near Newton. Collection of Mr. Pengelly.

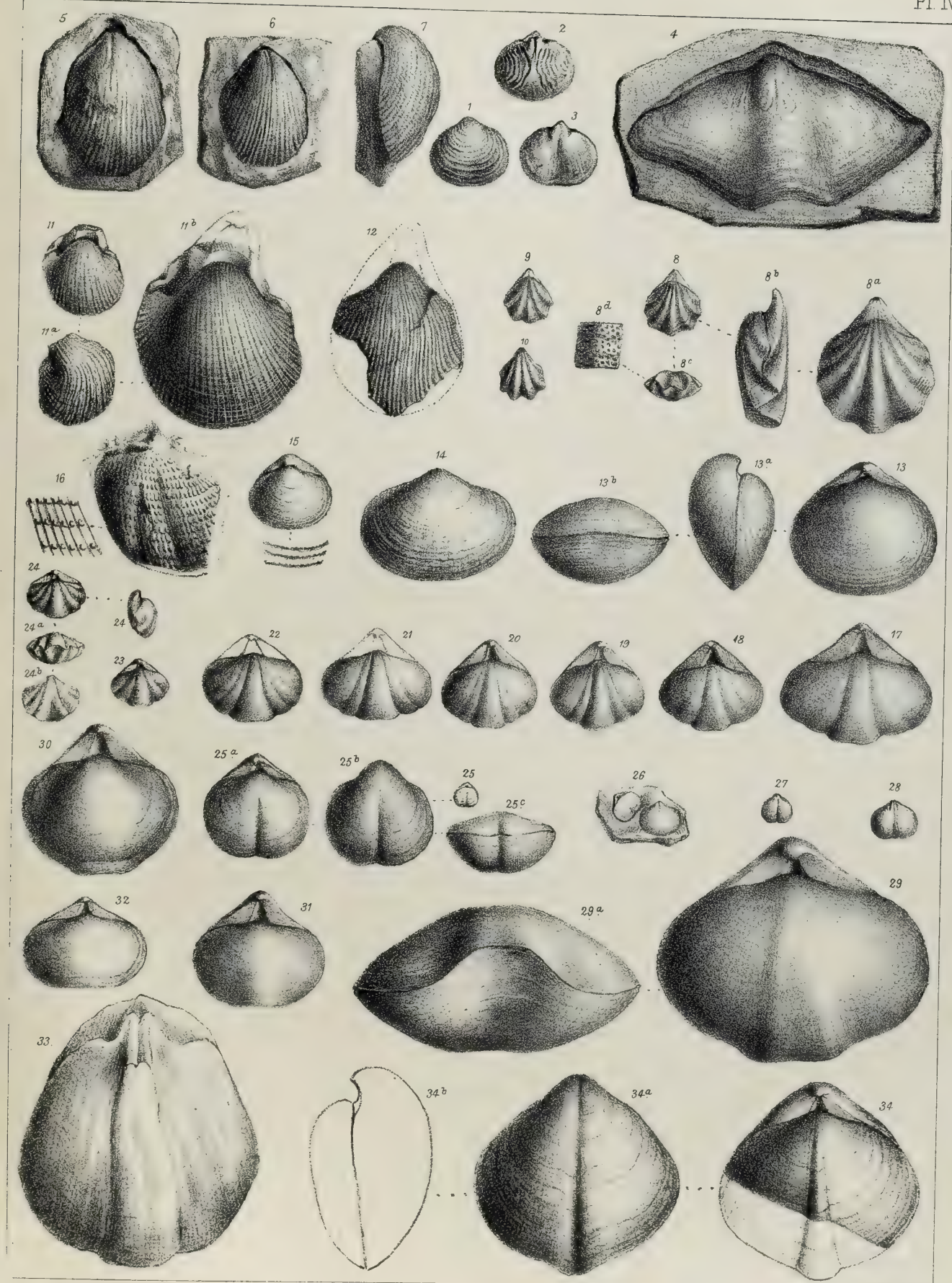


PLATE V.

DEVONIAN SPECIES.

FIG.

1. *Spirifera disjuncta*, Sow. = *Sp. Verneuillii*, Murch. After the original illustration, 'Trans. Geol. Soc.,' 2nd ser., vol. v, pl. liv, fig. 13. Upper Devonian, Petherwin, Cornwall.
2. " " Ibid., vol. v. pl. liii, fig. 8. This internal cast shows the muscular impressions. Barnstaple.
3. " " From South Petherwin. Correctly restored, from exact measurements.
- 4, 5, 6. " " Middle Devonian, Woolborough Quarry, near Newton Abbot. Fig. 4, Collection of Mr. Champenowne; fig. 5, Mr. Lee's Collection; fig. 6, Geol. Survey Coll.
7. " " Brown grits, Barnstaple.
8. " " = *Spirifera gigantea*, Sow. Flattened and distorted, in micaceous Devonian slate, at Tintagel, Cornwall. Sowerby mentions that some examples measured nearly nine inches across.
9. " " = *Sp. calcarata*, Sow. After the original illustration, 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liii, fig. 7. Barnstaple.
10. " " Brown grits, Upper Devonian, Croyde Bay, seven miles north-north-west of Barum. Coll. of M. M. Hall.
11. " " = *Sp. eatensa*, Sow. Distorted specimen. From South Petherwin, Cornwall. Mus. Geol. Soc.
12. " " = *Spirifer protensus*, Phillips. The original illustration, 'Pal. Foss. of Devon, Cornwall, and West Somerset,' pl. xxviii. South Petherwin. Mus. Geol. Survey. This is a decorticated, injured specimen, or cast; but as remains of the striation occur on several portions of the ventral valve, I have been able to give a correct restored illustration in fig. 12^a.

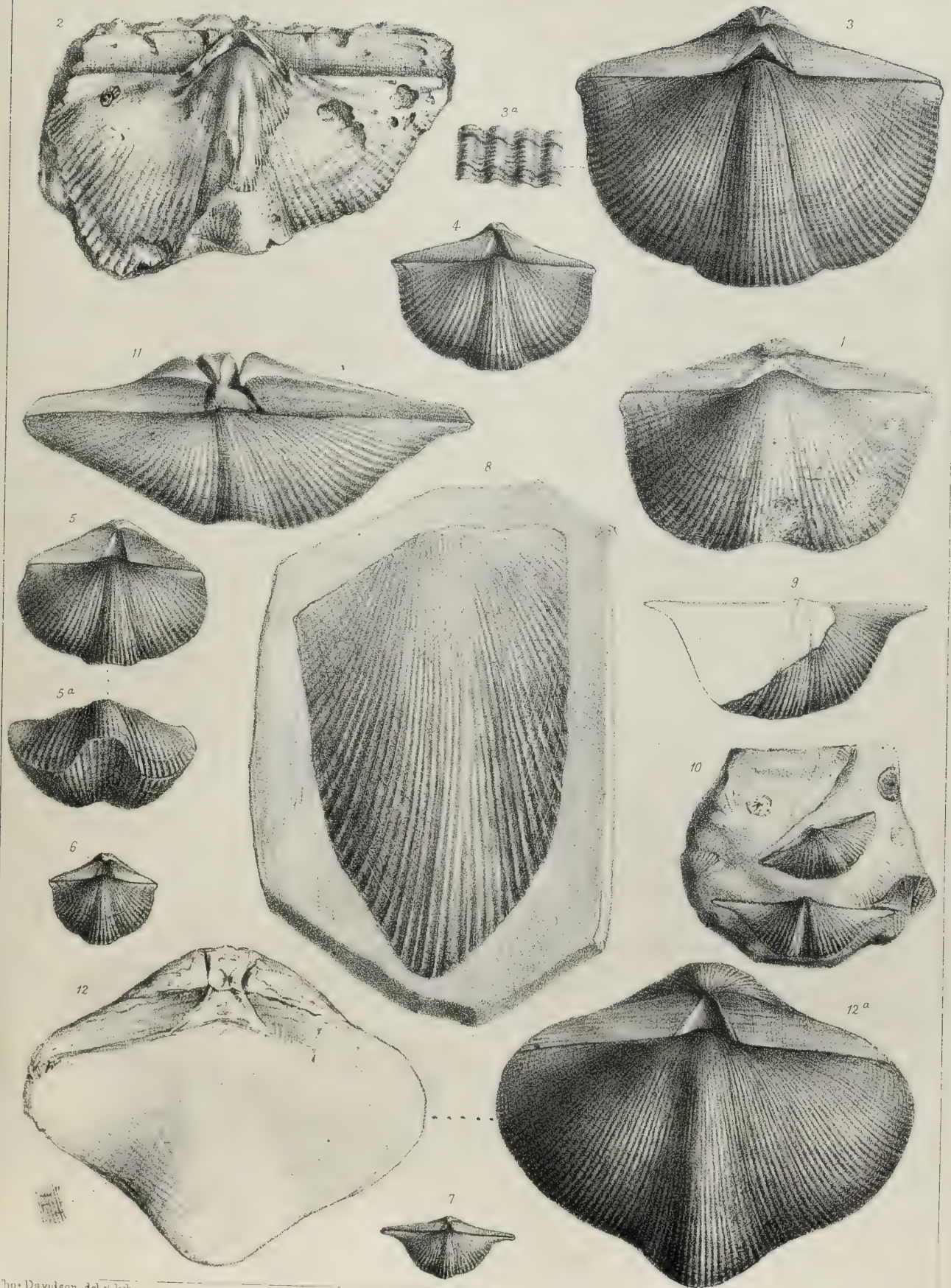


PLATE VI.

DEVONIAN SPECIES.

FIG.

- 1—4. *Spirifera disjuncta*, var. *Barumensis*, Sow. Fig. 1, a correctly restored measured representation, taken from two specimens in the brown grits, Upper Devonian, of Braunton. Fig. 2, a fragment from the Pilton beds, Croyde Bay. Fig. 3, from Braunton. Fig. 4 is taken from a gutta-percha cast, made from an impression of the shell left in the brown grit of Braunton. The area is unusually largely developed.
5. ,, ,, = (*Sp. distans*, Phillips, not of Sow., 'Palæozoic Fossils of Cornwall, Devon, and West Somerset,' tab. xxix, fig. 127). Devonian, near Newton. Collection of Mr. Lee.
- 6, 7. ,, ,, ? = *Sp. grandæva*, Phillips. After the original representation, pl. xxx, fig. 131. Upper Devonian, South Petherwin, Cornwall.
8. ,, ,, = *Sp. mesomala*, Phillips. Pl. xxxi, fig. 137. Brushford, North Devon. This is the original figure, but to me undeterminable.
9. ,, *aperturata*, Schl. ? After Phillips, pl. xxx, fig. 133. Linton, North Devon. This fragment will not admit of a certain identification.
10. ,, *obliterata*, Phil. After Phillips, pl. xxxi, fig. 135. Brushford, North Devon.
- 11—15. *Spiriferina cristata*, var. *octoplicata*. Figs. 11, 12, 13, casts in the Devonian yellow grits of Looe, Cornwall. Figs. 14, 15, from the dolomite, Dartington, near Totness, Devon. Coll. of Mr. Champernowne. Found in the same beds with *Uncites gryphus*.
- 16, 17. ,, *insculpta*?, Phillips. Middle Devonian, Lummaton, near Torquay.
- 18—21. ,, *simplex*, Phil. Barton, Lummaton, and Woolborough. Collections of the Geol. Survey, Mr. Pengelly, and Mr. Vicary.

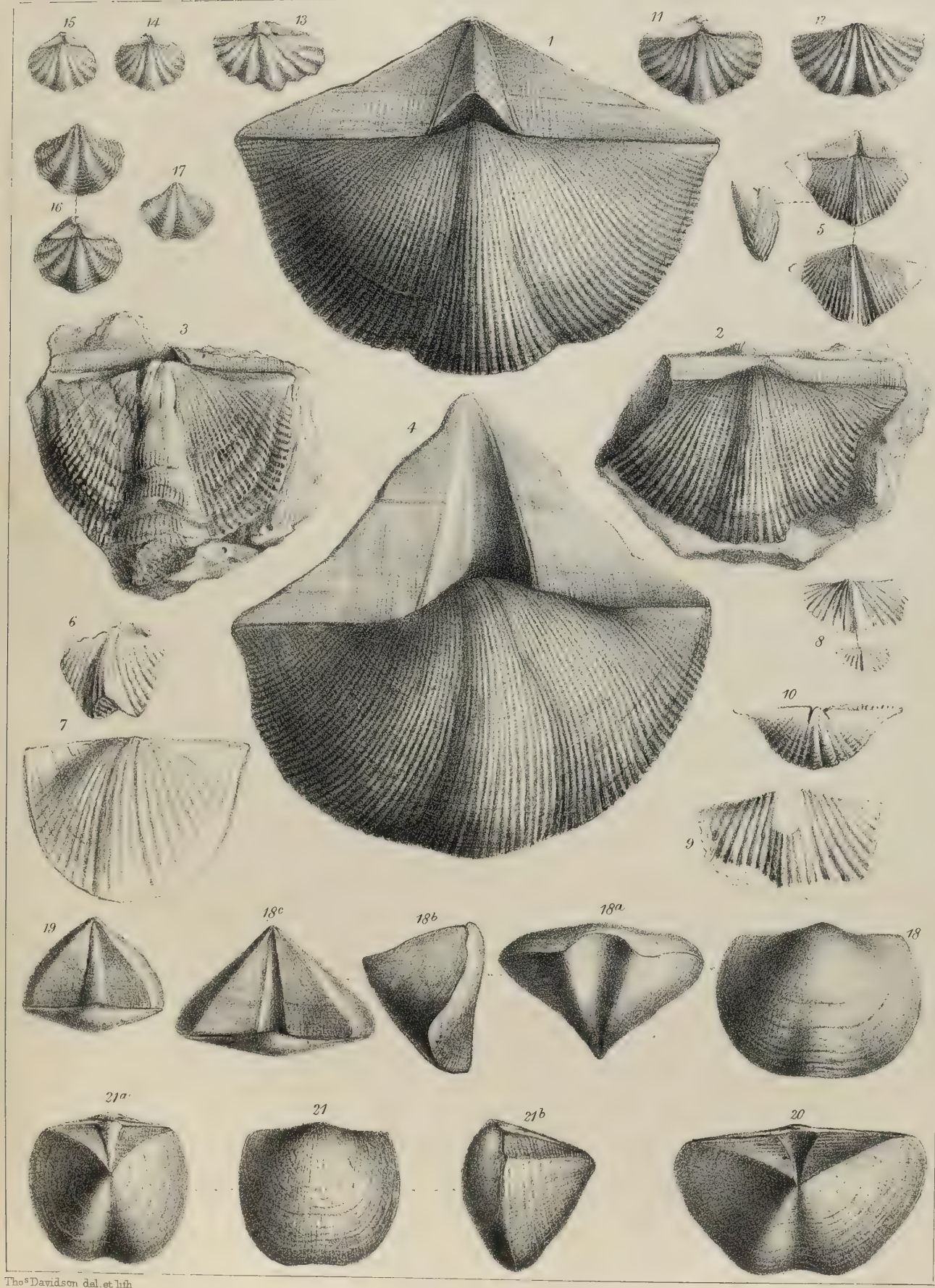


PLATE VII.

DEVONIAN SPECIES.

FIG.

1. *Spirifera undifera*, F. Roemer. Typical shape. Middle Devonian Limestone, near Newton Abbot. British Museum.
- 2—10. „ „ Several variations in shape. Fig. 2 preserves its concentric lines or sculpture. Figs. 2, 6, 7, 8, Woolborough (decorticated examples). Figs. 3—5 from Barton, near Torquay. Collection of Mr. Lee. Fig. 4, Mus. Geol. Survey. Fig. 10, *Sp. pinguis?*, Phillips, 'Pal. Foss. of Cornwall, Devon, &c.,' pl. xxxi, fig. 139. Barton, near Torquay. Collection of Mr. Lee.
- 11—14. „ „? var. *undulata*, F. Roemer. Several variations in shape, Woolborough Quarry. Collections of Messrs. Pengelly, Lee, and Vicary.



PLATE VIII.

DEVONIAN SPECIES.

FIG.

- 1—3. *Spirifera cultrijugata*?, F. Roemer. Internal casts and impressions. Lower Devonian?, Looe, Cornwall. Collection of Mr. Pengelly.
- 4, 5. „ *lævicosta*, Val. in Lamarck, = *Sp. ostiolatus*, Schl. Fig. 4, partly restored specimen, from Middle Devonian, Woolborough, near Newton Abbot. Fig. 5, from an imperfect specimen likewise, figured by Phillips ('Pal. Foss. of Cornwall, Devon, &c.,' pl. xxv, fig. 132^a); Valley of Rocks, Linton, Devonshire.
- 6—8. „ *speciosa*, Schlotheim. Hope's Nose, near Torquay. Fig. 6, Collection of Mr. Pengelly. Fig. 7, Mus. Geol. Survey. Fig. 8, Mus. Geol. Soc.
- 9, 10. „ „? = *Sp. costatus*, Sow. Fig. 9, after the original figure ('Trans. Geol. Soc.,' 2nd ser., vol. v, tab. lv, fig. 6); Fowey, Cornwall. Fig. 10, *Sp. costatus*, Phill. ('Pal. Foss.,' pl. xxx, fig. 134^c); Meadfoot Sand, near Torquay, Devon. Are these referable to *Sp. paradoxa*? The specimens are so imperfect as to be hardly determinable.
- 11, 13. „ „? = *Sp. paradoxus*, Schl. Fig 11, Hope's Nose, near Torquay. Fig. 13, Fowey, Cornwall. Mus. Geol. Survey.
12. „ (uncertain) It has been referred by the Survey Palæontologists to *Sp. Bouchardii*; but the width of the area negatives such a conclusion.
- 14, 15. „ *sub-cuspidata*, Schnur. Hope's Nose, near Torquay. Collection of Mr. Pengelly.
- 16, 17. „ *hysterica*, Schloth.? From Linton, North Devon. Sharpe's Collection, Mus. Geol. Soc.
18. „ „? Middle Devonian Limestone, near Plymouth.

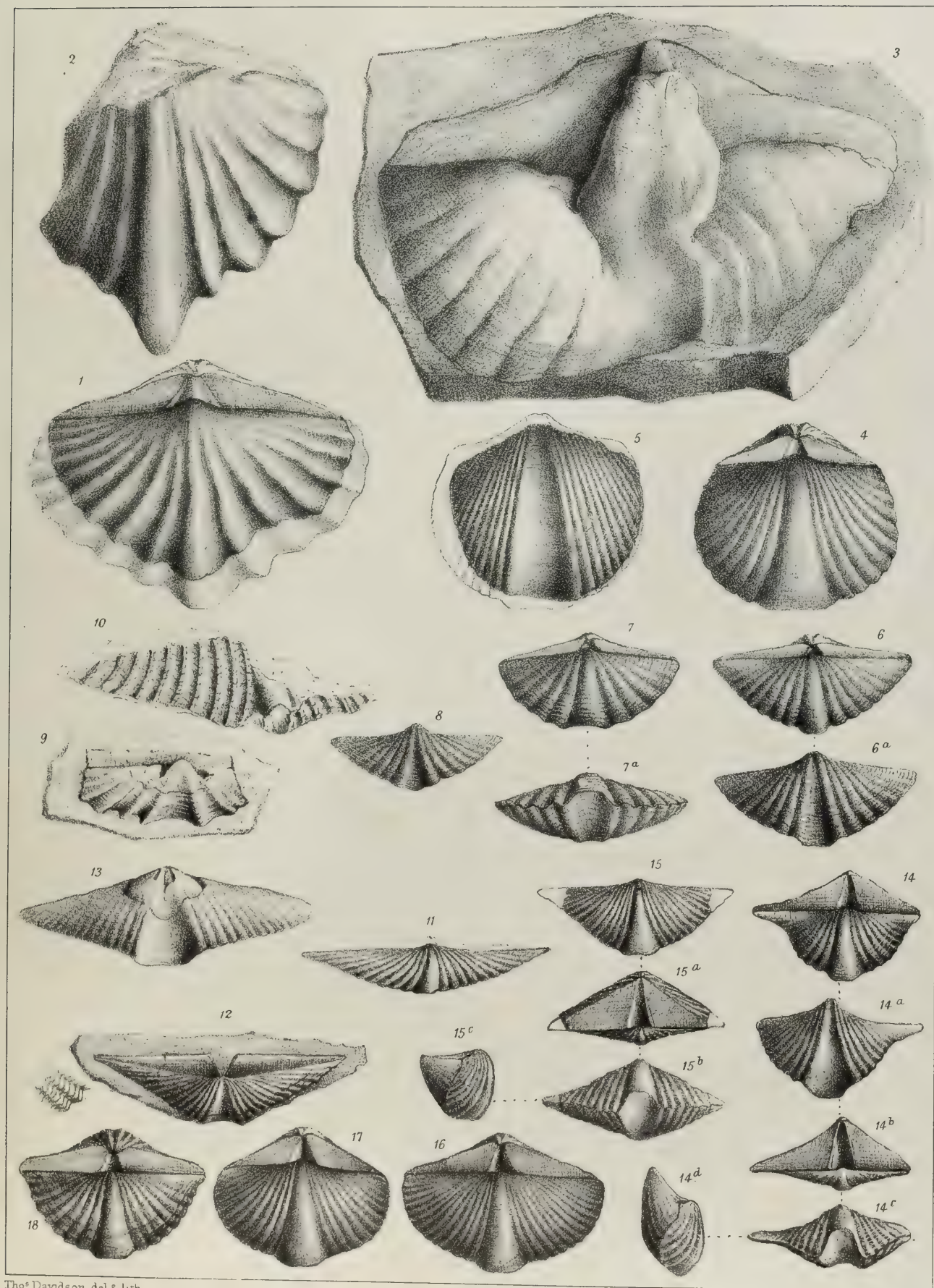
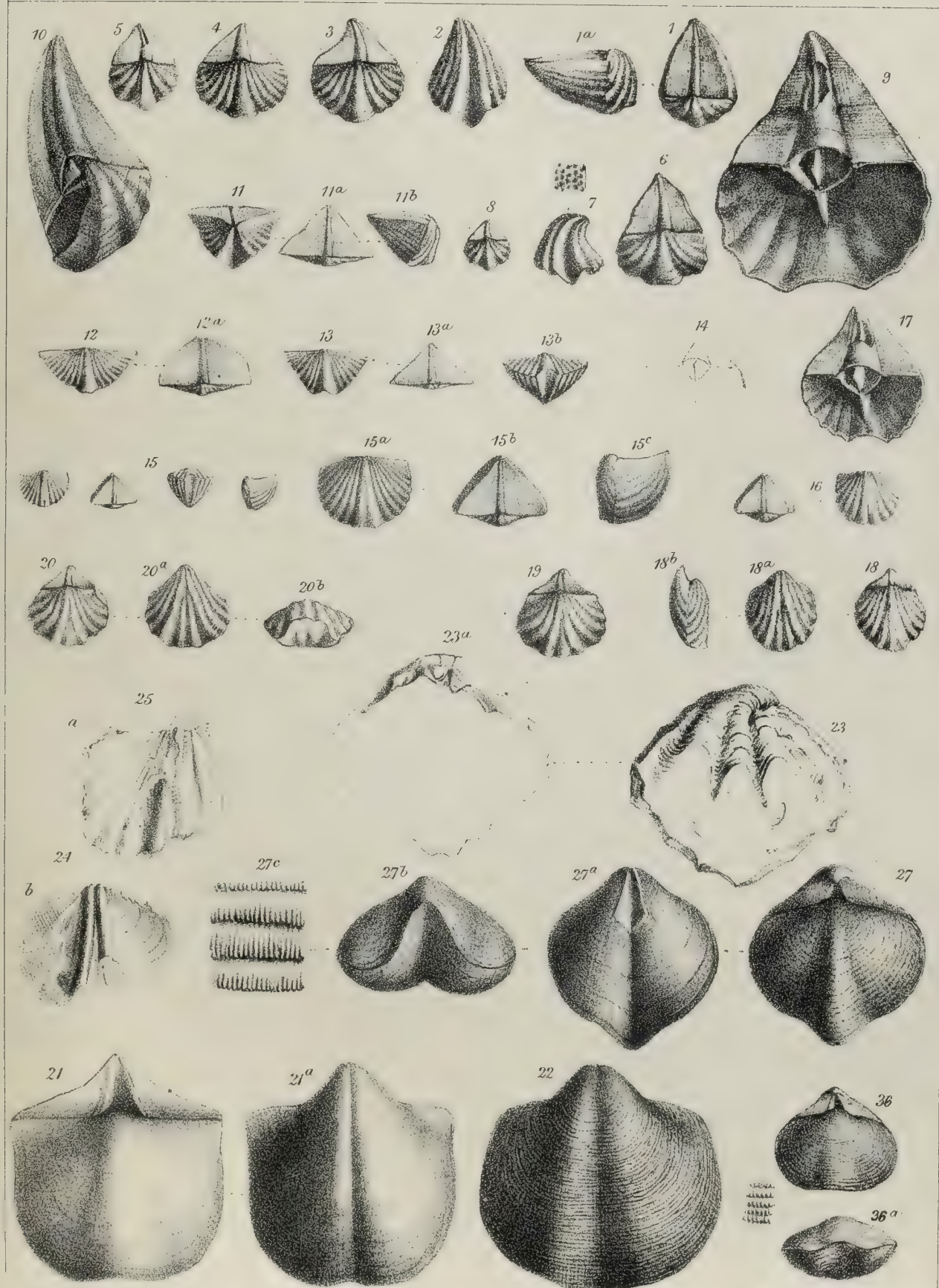


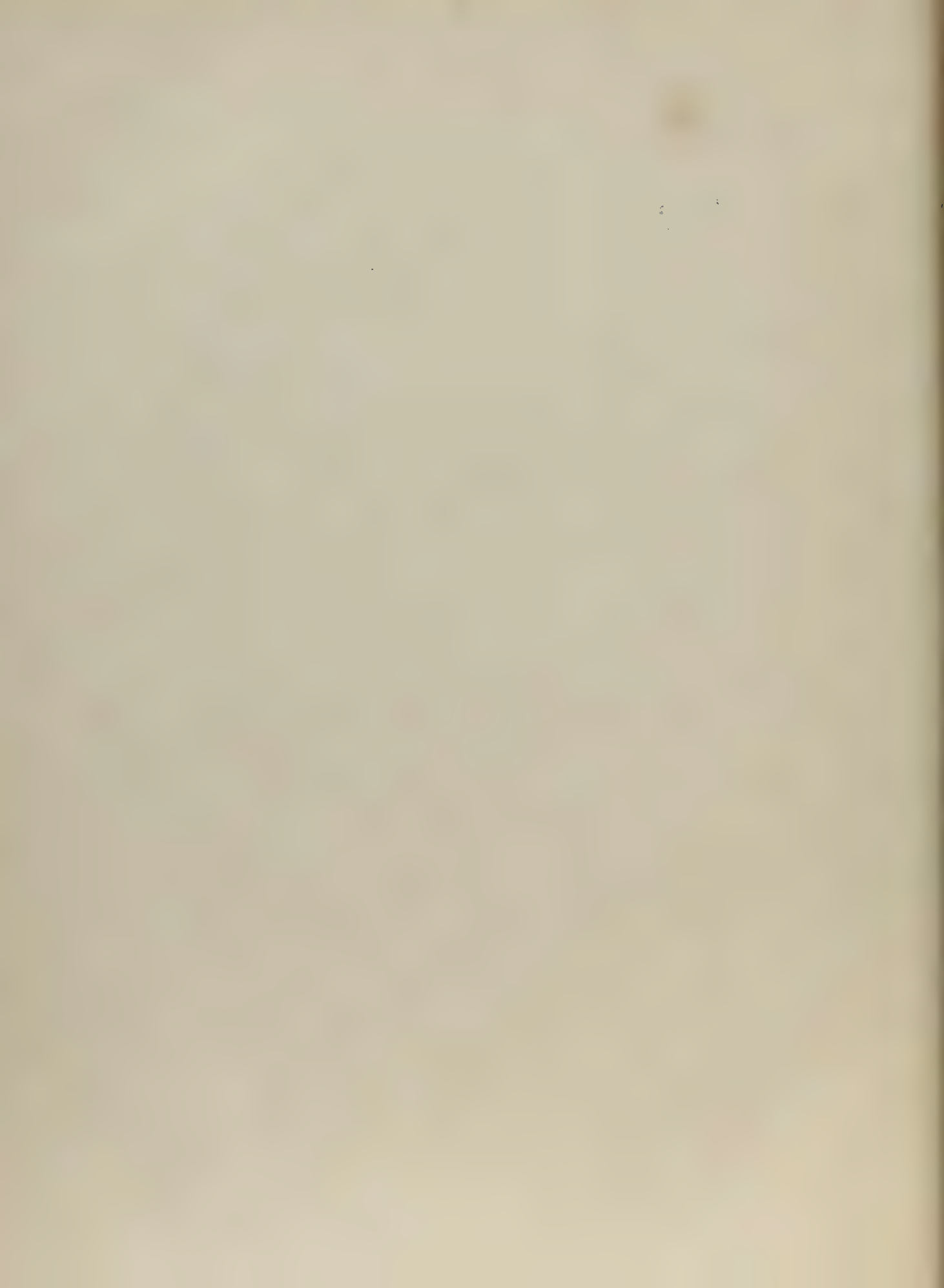
PLATE IX.

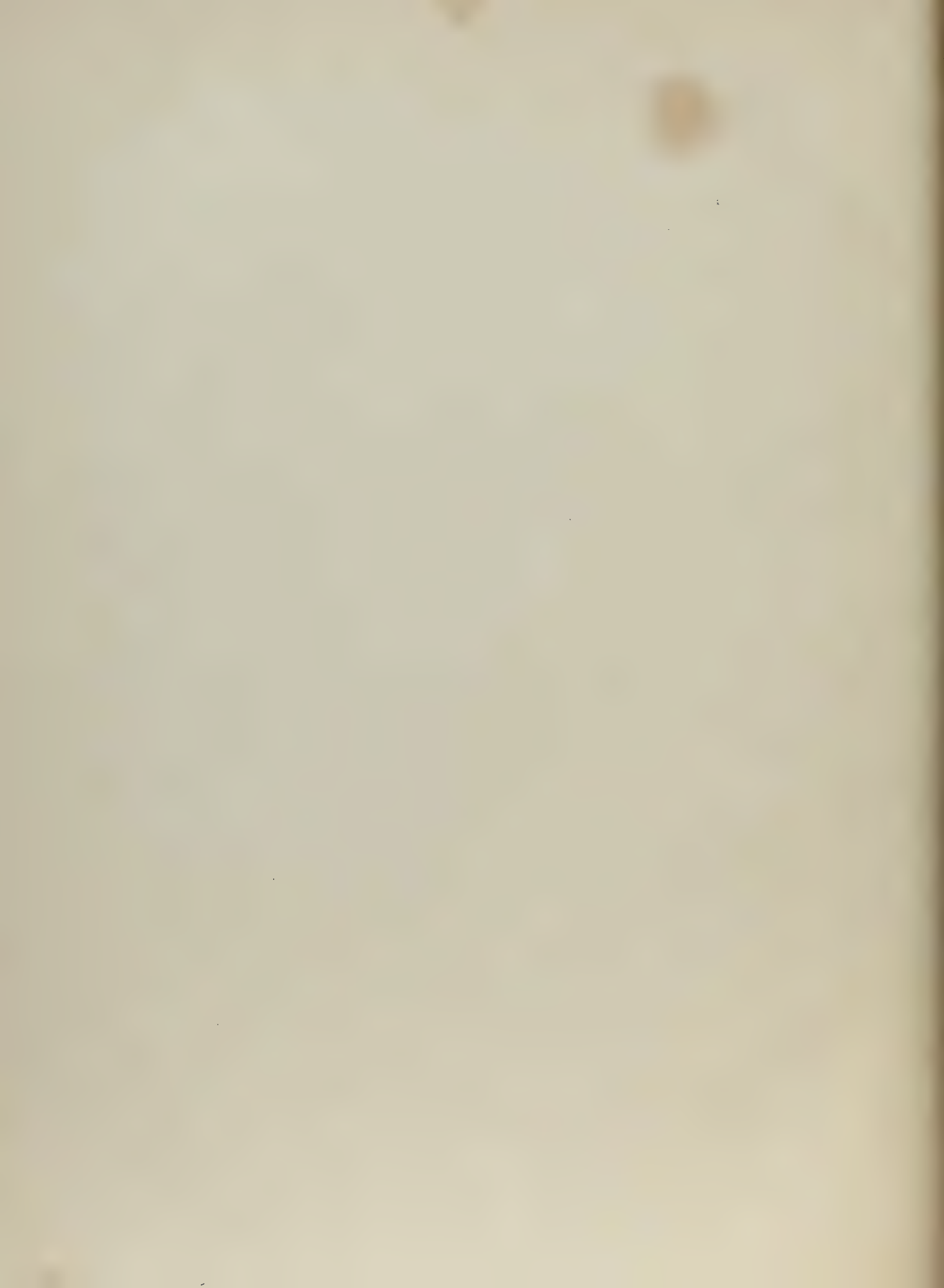
DEVONIAN SPECIES.

FIG.

- 1—10. *Cyrtina heteroclita*, Def. All the figures, with the exception of fig. 2, from Middle Devonian, Barton and Lummaton. Fig. 2, from Woolborough. Fig. 4, *Sp. subconica*, var., Sow., not Martin. Collections of Messrs. Lee, Pengelly, &c., Fig. 9, interior of the ventral valve, enlarged. Fig. 10, longitudinal section of the shell.
- 11—14. „ „? var. *Sp. cuspidatus*, Phillips, not Martin ('Pal. Foss., t. xxix, fig. 124). Barton and Lummaton, near Torquay. Collections of Messrs. Lee and Sharpe, &c.
- 15—17. „ *Demarlii*, Bouchard. Barton, near Torquay. Collection of Mr. Lee.
- 18—20. „ ? *amblygona*, Phill. Fig. 18, *Ter. amblygona*, Phill., from the original example, Barton. Collection of Mr. Lee. Figs. 19 and 20 from Barton and Lummaton, near Torquay.
21. *Spirifera Newtoniensis*, n. sp. Woolborough. British Museum.
22. „ *curvata*, Schloth., var. of *Sp. curvatus*? Woolborough Quarry. Collection of Mr. Champernowne.
23. „ *megaloba*?, Phill. After Phill., 'Pal. Foss. of Devon,' &c., pl. xxxi, fig. 140. Brushford. Undeterminable fragment.
- 24, 25. „ *rudis*?, Phill. After Phill., 'Pal. Foss.,' tab. xxxi, fig. 136. Baggy Point. Undeterminable fragments.
- 26, 27. „ *curvata*, Schloth. Fig. 26, Middle Devonian, Dartington, near Totness. Fig. 27, Hope's Nose. Collection of Mr. Champernowne.







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MDCCCLXIV.

A MONOGRAPH
OF
THE EOCENE MOLLUSCA,

OR,
DESCRIPTIONS OF SHELLS

FROM
THE OLDER TERTIARIES OF ENGLAND.

BY
SEARLES V. WOOD; F.G.S.

PART II.
BIVALVES.

LONDON:
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21. MODIOLA BARTONENSIS, *S. Wood*. Tab. XIX, fig. 18.

A small specimen of a *Modiola*, of which the figure above referred to is a representation, has very recently come into Mr. Edwards's possession. It is not in a state of preservation sufficient for full and fair description, and I have proposed the above name provisionally. It appears to be covered entirely with large rays or costulæ; it is more elongated than the fragment figured at fig. 5, Tab. X, and it has not the diversified rays which ornament that shell.

22. MODIOLA (?) CRASSISTRIATA, *Edwards*, MS. Tab. XIX, fig. 16.

Spec. Char. *M. testá parvá, ovato-trigonulá, tenui, siphoni-regione depressiusculá, radiatim costellatá aut crassistriatá; costellis vel striis rotundatis, dichotomis; umbonibus minimis, subterminalibus; margine cardinali subrecto.*

Shell small, ovately triangular, thin; siphonal region somewhat depressed, covered with thick radiations or riblets, rounded and bifurcating; beaks small, nearly terminal; dorsal area straight.

Length, $\frac{1}{2}$ an inch.

Locality. Bracklesham (*Edwards*).

The specimen above described has recently been added to the cabinet of Mr. Edwards, and I have considered it, as Mr. Edwards has done, a distinct species. It differs from both of the previously described coarsely striated species, *flabellula* and *nodulifera*, being much shorter than the former, with the striæ or riblets somewhat finer; and from the latter, with which it agrees in form, it differs in not having the nodules of that species. Our present specimen is a pretty shell, and the rays with which it is ornamented are rounded, the spaces between them rather narrow, or at least they are less so than the rays themselves. The specimen adheres too closely to the matrix to permit of a removal, and the interior is entirely hidden. It bears some resemblance to *M. pectinata*, Lam. (Desh., 'Coq. foss. des Env. de Par.,' t. 1, p. 259, pl. 39, figs. 6—8), but our shell is shorter, more angulated, with a comparatively longer dorsal area, and the striæ are coarser.

The umbo in this is nearly terminal, with a very trifling projection of the pedal region; there is an uncertainty as to its correct admission into *Modiola*.

MODIOLA DESHAYESIANA? *J. Sowerby*. Tab. XIX, fig. 19.

A shell from Mr. Edwards's cabinet here represented is referred with doubt to the Bracklesham species. The figure 14 of Tab. XIII was copied from Mr. Dixon's work, and a comparison could not be instituted. I have therefore thought it desirable to represent the present specimen, as it presents a difference in outline, and may possibly belong to another species; at least it constitutes a variety, which I will call *Hempsteadiensis*.

The form of our fossil is more pointed in the siphonal region than the figure of the Bracklesham or the Paris Basin specimens; it is less regularly cylindrical, and not so elongated, and there is a considerable slope from the extremity of the hinge-line to the siphonilateral margin. Several casts of specimens have been found, and there is on one individual a portion of the shell remaining which is very smooth and glossy, and with a magnifier the fine and faint cross or radiating striæ may be seen. The animal appears to have formed for itself a thickened lining to the crypt in which it dwelt. The only locality at present known is Hempstead, where it is found embedded in the shell of an oyster.

In the 'Quarterly Journal of the Geol. Soc.' for November, 1862, p. 330, is a paper by Dr. Sandberger, in which he speaks of a fossil from Hempstead as identical with *Mod. delicatula*, Desh. This British fossil was received by him from Mr. Edwards, and is the same species as the one I have had figured, but I cannot coincide in Dr. Sandberger's opinion. The following differences appear to me to be sufficient to keep the English and the French shells specifically distinct. The umbo is more terminal, the ventral margin less convex, the dorsal or hinge area shorter, and the siphonal region is more oblique and pointed in our shell than in *M. delicatula*. My comparison is dependent upon the characters given by M. Deshayes; but judging from the figure and description by that accurate and able naturalist, I think the two forms cannot be specifically united.

23. MODIOLA (?) CONSOBRINA, *S. Wood*. Tab. XIX, fig. 17.

Length, 2 inches.

Locality. Alum Bay (*Fisher*).

One specimen is all that I have yet seen, and that unfortunately is not in a condition for fair determination. It was found, Mr. Fisher tells me, in the Bracklesham bed at Alum Bay; the specimen is firmly imbedded in the matrix (a sandy marl), by which the interior is hidden, and the umbonal region is not quite perfect. It differs from *M. subcancellata* principally in having fewer and coarser rays, and it has not the concentric ridges or distinct lines of growth subcancellating the exterior of that species. The figure has

been a little too much improved at the umbo, and it is difficult in its present condition to say whether it belongs to *Mytilus* or *Modiola*. Its present name is merely provisional.

16*. *MODIOLA SUBCARINATA?* *Lamarck*. Tab. XIX, fig. 20.

At page 71, Tab. XII, fig. 9, is figured and described a shell from the London Clay at Highgate, and referred with doubt to Lamarck's species from the Paris Basin. Mr. Edwards has since obtained a specimen from Barton, with the general characters of the French species, although differing in some minor particulars, and I have thought it desirable that it should be represented. In comparing our present specimen with the figure of the Paris Basin species, there appears a difference in the length of the hinge-area, and also in the direction of the margins, both the dorsal and ventral margins being more curved in the French shell than in our own; there is also a slight difference between the Barton specimen and the one previously figured from Highgate, which has a more prominent or subcarinal projection, with the umbo rather more terminal.

Our shell is covered with elevated or rather imbricated lines of growth, and these are more distant upon the siphonal region than upon the other parts of the shell; they appear as if they once supported a fringed epidermis like that which ornaments the shell which has been called *M. barbata*.

Since the above was written and the figures engraved, I have seen a specimen in the cabinet of Mr. Prestwich of the following dimensions:— $3\frac{1}{4}$ inches in length, with a height or breadth of 1 in., and a tumidity of an inch and half: this was obtained at Clarendon Hill, near Salisbury, and I presume it to be the same as *M. subcarinata* from Highgate.

24. *MODIOLA SUBCANCELLATA*, *Edwards, MS.* Tab. XIX, fig. 15.

Locality. Barton (*Edwards*).

An imperfect specimen has recently come into the possession of Mr. Edwards, to which is attached the above specific name. It bears considerable resemblance to two species from the Paris Basin, viz., *Mod. Rigaultii*, Desh. ('An. sans vert. du Bass. de Paris, t. 1, p. 29, pl. 74, figs. 23, 24), and *Mod. Levesquei* (id., p. 30, pl. 75, figs. 4, 5); our shell appears to approach rather nearer to the latter, and, if the specimens themselves could be compared, might possibly be referred to that species; there are, however, some differences which may be here pointed out. The Barton shell does not appear to have been so broad or so high as that of the French species, neither has it so long an area for connexus; the dorsal edge is finely but deeply denticulated, as that of *M. Levesquei* is also represented to be, but it does not appear so much curved as in the latter. There

are two rather unequal and not very perfect teeth immediately beneath the umbo, within which is also the impression of the oral adductor; the external radiations are numerous and flat, and they bifurcate at an early age; the interspaces are ornamented with raised lines of growth, which impart to them an irregularly cancellated appearance, and these, if they exist, are not represented in the French shell. In the young state, the form resembles more the normal state of *Modiola*, which it seems to have nearly lost in the adult, where the umbo has become more pointed, like that of *Mytilus*.

ARCA. *Linnæus*.

Generic Character. Shell inequilateral, generally equivalved, more or less quadrate or trapezoidal; ventral margin sometimes closed, at others open or sinuated; externally covered with radiating striæ; umbones distant, with more or less open area for connexus; hinge straight, with many teeth; palleal impression entire.

This is almost exclusively a marine genus, and comprehends nearly five hundred species. Some of these, however, vary so materially in the form, number, and arrangement of the denticles upon the straight and elongated margin of the hinge, as to have been separated into several genera or sections, in accordance with those variations. The generality of species show an opening more or less in the ventral margin, indicating a habit in the genus to spin a byssus.

In some few species there is an inequality in the valves; when this is the case, the left one is the larger of the two, and this inequality is found principally in those species which are without a sinuated margin.

The hinge, or dental area, is quite straight; this in some species is furnished with numerous small teeth placed at right angles to the line of it; in others, the denticles are few in number and are variously inclined, until they become at the extremities parallel with the hinge-margin, exhibiting every possible degree of intermediate variation. The shells that have been generally included in this genus from the older rocks have most of them very oblique denticles, like those of *Cucullæa*, but they are not restricted to that form of dentition. The area between the umbo and the dental margin over which the connector is spread is at times very large and open; the diverging and chevron-formed lines which ornament this space are deeply impressed in the shell; into them a portion of the ligament has been inserted for strength and protection, as also to have an intervening raised portion on which to act as a fulcrum. There is in this character an approach to *Limopsis*, in which there is an angular depression; but it has not any analogy with the bipartite or amphidesmous form of connexus, inasmuch as the action of the whole connector is ligamental, acting by contraction and elongation. In *Pectunculus* the area is marked with a single divergence, forming an obtuse angle; but in the present genus, in which some of

the more inequilateral species have a large, open, and elongated space for connexus, the linear portion diverges from the umbo at an acute angle; and thus a greater strength is given to these lines than if they were spread over the entire surface. If the same mode of divergence existed in the siphonal region of these shells, the linear portions of the ligament would be extended at an angle so obtuse, that they would be almost useless for a ligature, and therefore another set of divergent lines is formed on this part of the dorsal area, by which a greater tenacity is obtained and the firmer union of the two valves is secured.

1. *ARCA APPENDICULATA*, *J. Sowerby*. Tab. XIV, fig. 3, *a—c*.

ARCA APPENDICULATA. *J. Sow.*, Min. Conch., t. 276, fig. 3, 1820.

— *DUPLICATA*. *J. Sow.* Min. Conch., t. 474, fig. 1, 1824.

— — — *Morris*. Catal. Brit. Foss., p. 185, 1854.

— *LACTEA*. *Solander*, in Brand. Foss. Hant., t. 8, fig. 106, 1766.

— *SULCICOSTA*. *Nyst*. Coq. foss. Belg. p. 257, pl. 18, fig. 9, *a, b*, 1843.

Spec. Char. *A. testá elongatá, subtrapezoidali, gibbosulá, inæquilaterali, æquivalvi, radiatim striatá vel costulatá, concentricè decussatá; costulis duplicatis vel bifurcatis; siphoni-regione longiore, obliquè truncatá; pedi-regione supernè angulatá, infernè rotundatá; umbonibus subprominentibus, incurvis; areá connexús magná, partim ornatá.*

Shell elongate, irregularly trapezoidal, tumid, inequilateral, equivalve, radiated with prominent lines or riblets, decussated by lines of growth; pedilateral margin angular above and rounded below; siphonal region angulated; beaks rather prominent, with a large area for the connector, partly lineated.

Length, $1\frac{1}{2}$ inch; *height*, $\frac{3}{4}$ ths of an inch.

Localities. Barton.

Belgium, Vliermael, Hoesselt, and Lethen (*Nyst*).

This species is in England restricted to the above locality, where it is not very rare; and as I believe the four names above mentioned belong to one and the same species, I have adopted *appendiculata* as being the older of the four. The peculiar appearance which suggested the name appears to be a plain and naked space on the pedal side of the area for connexus, which is free from any diverging impressed lines, while they are distinct on the siphonal side; at least I presume this to be so; I am quite unable to see anything like appendages to this part of the shell. The exterior of the valve is ornamented with radiating striæ or riblets, and these generally duplicate, sometimes triplicate, on the outer or older portion of the shell; the lines of growth are prominent, decussating the interspaces as well as the rays, which, in consequence, become somewhat nodulous, particularly over the pedal region; the dental area is furnished with teeth along the entire length; they are at nearly right angles to the hinge-line, but incline as they recede from the centre.

2. ARCA AVICULINA? *Deshayes*. Tab. XV, fig. 7, *a*, *b*.

ARCA AVICULINA. *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 887, pl. 66, figs. 15—17, 1858.

Spec. Char. *A. testá elongatá, angusto-subcylindraceá, depressiusculá, inæquilaterali, radiatim eleganterque costellatá; costellis inæqualibus, in medio tenuibus; extremitatibus crescentibus, elevatis, subimbricatis; umbonibus depressis, brevibus; areá connexús parvá; areá dentali paucidentatá.*

Shell slender, elongate, subcylindrical, somewhat depressed, inequilateral, elegantly covered with rays or small ribs; rays smaller or thinner in the centre, enlarging towards the lateral margins; beaks small, depressed; area of the connector narrow; dental margin sparingly furnished.

Length, $1\frac{3}{8}$ inch; *height*, $\frac{9}{16}$ ths.

Localities. Bracklesham, Bramshaw, Brook (*Edwards*), Huntingbridge (*Fisher*).

This is an elegant species, and, I believe, not very rare. There is considerable difference between our shell and the figure of the French species, to which it is here doubtfully referred; but I feel unwilling to separate them upon what do not appear to be essential distinctions. There is also a difference between the British specimens from different localities, those from Bramshaw and Brook being more delicately rayed than those from Huntingbridge and Bracklesham. In general, our shell appears to be less cylindrical than that of the Paris Basin species; but in this character our own specimens vary materially. The principal difference is in the position of the umbo, which is more eccentric in the British than in the French shell, and in this character the former more closely approaches *A. interrupta*, where the siphonal region is also broader or higher; but it differs from that species in being longer, differently rayed, and in having the central portion somewhat compressed, with an inflated or tumid siphonal region.¹

3. ARCA BIANGULA, *Lamarck*. Tab. XIV, Fig. 1, *a—f*.

ARCA BIANGULA. *Lam.* An. du Mus., t. vi, p. 219, 1809, and t. ix, pl. 19, fig. 4, *a*, *b*, 1824.

— — *Desh.* Coq. Foss. des Env. de Par., t. i, p. 198, pl. 34, figs. 1—6, 1824.

— BRANDERI. *J. Sowerby.* Min. Conch., t. 276, figs. 1, 2, 1821.

— HYANTULA. *Desh.* Coq. Foss. des Env. de Par., t. i, p. 199, pl. 34, figs. 7, 8, 1824.

— — *Goldf.* Petr. Germ., vol. i, p. 143, t. 122, fig. 3, *a—d*, 1826.

BYSSOARCA BRANDERI. *J. Sow.*, in Dixon's Geol. Sussex, pp. 92, 169, t. 111, fig. 23, 1850.

¹ Since the above has been in press, I have seen the description and figure of *Arca Laekeniana*, Le Hon. ('Descr. succ. de quelq. nouv. esp. des terr. tert. Eoc. des env. de Brux.', p. 7, No. 15), a species which more resembles our fossil than does the one to which it is here doubtfully assigned, but the rays upon our shell are somewhat different; they are apparently more distant, and have intermediate striæ, which are neither shown nor said to exist upon the Belgian fossil. I think, however, that when specimens of each can be compared, they may be found to be identical.

Spec. Char. *A. testá variabili, plerumquè oblongá, angustatá, subtetragoná, subobliquá, valdè inæquilaterali, striatá; umbonibus distantibus, recurvis; siphoni-regione productá, biangulatá; striis radiantibus, numerosis, squamoso-granulatis.*

Shell variable, for the most part elongately oblong; somewhat oblique, very inequilateral; umbones distant, recurved; siphonal region much the larger, biangulated; striæ numerous, granulated, and slightly imbricated.

Length, 3 inches; *height*, 1 inch.

Localities. Bracklesham, Selsey; var. β , Barton.

France, Grignon, Courtagnon, Senlis, Valmondois (*Desh.*).

The ligamental area in this species has a broad, flat, and deep depression, with chevron-formed lines, which when the valves are united form lozenge-shaped ornaments immediately beneath the umbo, one within the other, the smaller closely approaching the hinge-margin; sometimes there is another set of the lozenge-shaped marks on the siphonal region, but these latter are more often only parallels to the radiating umbonal lines. In specimens from Barton this area is tinged with a dark-red colour by the remains of the ligamental connector. The hinge-margin is furnished with numerous small teeth, rather more strongly displayed in the young state than in the old. Most of the large specimens from Bracklesham have the outside much eroded and nearly smooth, like specimens of *A. tetragona* that have inhabited some crypt where the movements of the animal have abraded the otherwise striated surface of the shell. This species is particularly abundant at Bracklesham, where it attains to large proportions. In the full-grown shell from that locality there is generally a large sinus, the ventral margin being deeply indented; but in the younger shells from the same locality this is not so strongly marked, and in some of those from Barton the valves are quite closed; it is so, however, with various specimens of *A. tetragona*. The shell called *A. biangula*, from the Bordeaux and Touraine beds, is by M. Deshayes considered as not identical with the Paris Basin species, and in this I think he is correct. There is, however, a slight difference between our own shell and that of the Paris Basin, ours being more finely striated all over, especially so upon the pedal region. Mr. Sowerby has retained the name of *A. Branderi* for the British fossil, which, he says (p. 169), "differs from *A. biangula*, *Desh.*, in having a much less acute keel." The keel, however, is variable in that respect among the French fossils, and this difference does not always exist in the British shell. The pedal region in specimens from Barton is sometimes broader or higher than in those from Bracklesham; this arises from a less sinuated margin, which otherwise contracts the shell at that part; the large rays have generally a smaller intermediate one, and these are decussated by very visible lines of growth. The Barton shell may, perhaps, be considered as a variety under the name *Branderi*, but I think there is not a specific difference; it much resembles *A. miniata*, *Desh.*

4. *ARCA DEPRESSA*, *J. Sowerby*. Tab. XIV, fig 4, *a—c*.*ARCA DEPRESSA*. *J. Sow.* Min. Conch., t. 474, fig. 2, 1824.— — *Morris*. Catal. Brit. Foss., p. 185, 1854.

Spec. Char. *A. testá tenui, elongato-oblongá, valdè inæquilaterali, depressá, radiatim striatá et concentricè decussatá; striis tenuibus, distantibus, subtuberculatis; marginibus ventrali et dorsali subparallelis.*

Shell thin, elongately oblong, very inequilateral, depressed, radiately striated, and concentrically decussated; striæ thin, and slightly tuberculated; ventral and dorsal margins nearly parallel.

Length, $\frac{7}{8}$ ths of an inch; *height*, $\frac{1}{2}$ an inch.

Localities. Woolwich (*Sowerby*), Basingstoke (*Prestwich*).

The specimens of this species that I have seen are very few and imperfect, and the characters for specific determination are not satisfactorily displayed. The principal distinction appears to be its depressed form, or shallow valve; the striæ upon the exterior Mr. Sowerby describes as "very distant upon the anterior side (siphonal region?), and appear like small knotted threads;" those on the shorter or pedal region are close, with interspaces of the same width. The cast of a species of *Arca* in Mr. Prestwich's cabinet from New Cross, Tab. XV, fig. 15, has the above name (in MS.) attached, and I have had it figured, as it appears somewhat to differ in being more inequilateral; but it is scarcely possible to determine a species from a cast alone.

5. *ARCA DULWICHENSIS*, *Edwards*, MS. Pl. XV, fig. 6, *a, b*.

Spec. Char. *A. testá ovato-oblongá, subobliquá, gibbosulá, valdè inæquilaterali, utrâque extremitate latè obtusá, in medio depresso-sinuosá, radiatim costellatá; costulis angustis prominulis, in siphoni-regione distantioribus; cardine—?*

Shell ovately oblong, slightly oblique, somewhat gibbous, greatly inequilateral; each extremity broadly obtuse; ventral margin slightly sinuated, covered with radiating riblets, rather distant upon the siphonal region; hinge—?

Length, $1\frac{7}{8}$ inch; *height*, $\frac{7}{8}$ ths of an inch.

Locality. Dulwich (*Edwards*).

A few specimens of a shell, apparently belonging to this genus, have been turned out of the "diggings" for the main sewer at Dulwich; they enrich the cabinet of Mr. Edwards. These specimens, unfortunately, do not exhibit to view the hinge-area; but the exterior has the form and sculpture which generally characterise the genus *Arca*. The valves have been pushed a little out of their natural position, and display a few elongated furrows and ridges nearly parallel with the dorsal or outer margin of the shell; these

resemble the parallel lines upon *A. heterodonta*, Desh. ('An. sans vert. du Bass. de Par.,' p. 906, pl. 67, figs. 22—25), but the lines upon our shell appear to be in the area for connexus, and not upon the dental margin; this I am unable correctly to ascertain. Our shell is very inequilateral, and the siphonal region is not only longer, but larger and higher; the radiations are a little wider or further apart on the larger or broader portion of the shell than upon the pedal region. This shell resembles, in outline, *A. obliquaria*, Desh. (id., p. 893, pl. 67, figs. 8—10, 10 bis), but is larger, shorter, and not quite so oblique. It is separated from *A. depressa*, as well by difference in outline as by the apparent difference in the hinge-area.

6. *ARCA EXIMIA*, *Edwards*, MS. Tab. XV, fig. 3.

Spec. Char. *A. testá elongatá, obliquè sub-quadrangulari, valdè inæquilaterali, sub-depressá, radiatim costulatá et concentricè decussatá, punctatá; umbonibus prominentibus, distantibus; areá connexús levigatá; dentibus medianis minimis; siphoni-regione productá.*

Shell elongate, oblique, irregularly quadrangular, very inequilateral, somewhat depressed, punctated, covered with radiating lines or riblets, crossed by distinct lines of growth; beaks rather prominent; area of the connector rather narrow and smooth; teeth small in the middle of the dental area; siphonal region produced.

Length, $\frac{3}{4}$ ths of an inch.

Locality, Brook (*Edwards*).

A single specimen of the left valve of a species which appears to be quite distinct, and to which is attached the above MS. name, is in the cabinet of Mr. Edwards; it is not quite perfect, and so closely attached to the matrix that I am unable to see the interior. Its nearest relative is, I think, *A. punctifera*, Desh. (p. 202, pl. 32, figs. 13, 14), but it differs from that species in several characters. The English shell appears to be more elongated and more inequilateral, and to have the area for connexus larger and broader than that described in the French shell, in which it is characterized as being so small and narrow as to bring the umbones almost close together, giving thereby a very small extent for the marginal separation of the valves. Our shell has the surface regularly rayed, with rather narrow and rounded single lines, which are decussated by broad and prominent lines of growth, leaving between each a deep depression or puncture; and where the rays are narrowest these punctures are, of course, most numerous. The area for connexus is broad, flat, concave, and smooth, and widest over the pedal region; the denticles are close and numerous, inclining towards the extremity of the hinge-line. I am unable to see if the internal edges of the margin be denticulated. *A. exornata*, Desh. ('An. sans vert. du Bass. de Par.,' p. 889, pl. 69, figs. 1—3), as also *A. intersecta*, figs. 25—27, resemble it in some characters.

7. *ARCA GLOBULOSA* (?), *Deshayes*. Tab. XV, fig. 9, *a*, *b*.

ARCA GLOBULOSA. *Desh.* Coq. Foss. des Env. de Par., t. i, p. 209, pl. 33, figs. 4—6, 1824.

Spec. Char. "*A. testá ovato-oblongá, brevi, gibbosá, globulosá, subcordatá, inæquilaterali, obliquatá, striatá, striis alternis minoribus, lævigatis; cardine arcuato, multidentato (?) ; margine crenato.*"—*Deshayes*.

Shell ovately oblong, short, tumid, or somewhat globular or gibbous, inequilateral, oblique, and striated; striæ alternately large and small; dental margin slightly curved; ventral margin deeply crenulated.

Length, $\frac{1}{8}$ th of an inch; *height*, $\frac{1}{12}$ th of an inch.

Locality. Highcliff, Barton.

This is not particularly rare. I have referred it, with considerable doubt, to the Paris Basin shell. It may possibly be a variety, *subglobulosa*.

On comparison with French specimens, I find that the English shell is rather smaller, less quadrate, or more rounded on the siphoni-lateral margin; and the dental area in the French shell is longer, and furnished with more numerous teeth, 17, 18 (*Desh.*); our specimens have four denticles on one side of the umbo and five on the other; those on the siphonal side are much inclined, almost parallel with the margin at the extremity, and, from the comparatively great depth of the valve, I imagine that our shell is a full-grown species, and not the fry of a larger one. The sculpture on the exterior resembles that upon *A. scapulina*, the rays being alternately one large and one small; the smaller rays are nodulous, and the interspaces are decussated, the lines of growth being large, prominent and regular, thickening periodically the smaller rays; but the larger rays are nearly smooth. There appears to be in this species a small triangular fossette beneath the umbo, like that in *A. lævigata*, dividing the connector into two different arrangements, as in *Limopsis*.

8. *ARCA IMPOLITA*, *J. Sowerby*. Tab. XV, fig. 4, *a*, *b*.

ARCA IMPOLITA. *J. Sow.* Geol. Trans., 2nd ser., vol. v, p. 136, pl. 8, fig. 10, 1834.

— — *Morris.* Catal. Brit. Foss., p. 185, 1854.

Spec. Char. *A. testá oblongá, convexá, tumidá, lævigatá, glabrá; valdè inæquilaterali, pedi-regione brevi, rotundatá; siphoni-regione sub-quadratá; marginibus intus integris; dorsali et ventrali sub-parallelis.*

"Transversely oblong, very convex; marked with longitudinal rows of punctures; anterior portion small, rounded; posterior rounded; front parallel to the hinge-line; shell thin."—*J. Sowerby*.

Length, $\frac{3}{8}$ ths inch; *height*, $\frac{3}{8}$ ths inch.

Localities. Hampstead, Potter's Bar, Highgate, Haverstock Hill (*Edwards* and *Wetherell*).

"It approaches *A. cucullaris*, Desh. (vol. i, p. 206, pl. 33, figs. 1, 2, 3), but differs slightly in form as well as in the teeth being all transverse."—*J. Sowerby*.

All the specimens of this species that I have been able to see have the two valves united, and the dentition obscured; it resembles *A. nitens* of the same deposit, but is less oblique.

A small individual in Mr. Wetherell's cabinet (fig. 4, *c*) appears to be free from all exterior ornament; it is possible that this may be the result of abrasion. There are also a few specimens of this genus in the same cabinet from the well at Hampstead, which are in a mutilated condition, and not sufficiently perfect for determination; they resemble the present species in shape, but appear to be more strongly and distinctly radiated.

9. ARCA INTERRUPTA, *Lamarck*. Tab. XV, fig. 2, *a, b*.

ARCA INTERRUPTA. *Lamk.* (non *Poli*). Ann. du Mus., t. 6, p. 220, No. 5, 1809.

— — *Desh.* Coq. Foss. des Env. de Par., t. i, p. 213, pl. 32, figs. 19, 20, 1824.

— — *Id.* An. sans Vert. du Bass. de Par., t. i, p. 888, 1858.

— — *Morris.* Catal. Brit. Foss., p. 185, 1854.

BYSSOARCA INTERRUPTA. *J. Sow.*, in *Dixon's Geol. of Suss.*, p. 93, t. 111, fig. 21, 1850.

Spec. Char. *A. testá obliquá, ovato-oblongá, compressá, valdè inæquilaterali; costulatá et decussatá; pedi-regione angustiore, siphoni-regione latiore et longiore; cardine brevi, in medio edentulo, ad utramque extremitatem recurvo, pauci-dentato.*

Shell oblique, ovately oblong, compressed, very inequilateral; striated and decussated by lines of growth; pedal region narrow and short; hinge area edentulous in the centre; extremities with few oblique denticles; ligamental area narrow; umbones approximate.

Length, 1 inch; *height*, $\frac{1}{2}$ inch.

Localities. Bracklesham, Selsey (*Edwards*).

France, Grignon, Parnes, Mouchy, Fontenay, Auvers (*Deshayes*).

A fine series of this shell enriches the cabinet of Mr. Edwards. It is slightly compressed in the centre and contracted in the ventral margin opposite the umbo, but it has very little gape. The hinge-area contains about six or seven denticles, those on the pedal side (three or four) are very slightly inclined to the hinge-margin, neither are the three or four on the siphonal side quite parallel with the dorsal edge. Between the striæ or costæ, which strongly denticulate the margins, there is an intermediate ray. Some of the French specimens are a trifle broader in the siphonal region than in the English shells, and the intermediate ray is scarcely so prominent.

10. *ARCA LÆVIGATA*, *Caillat*. Tab. XV, fig. 8, *a*, *b*.

- ARCA LÆVIGATA.* *Caillat*. Desc. des quelq. Coq. Nouv., p. 4, pl. 2, fig. 7, 1834.
 — — *Nyst.* Tabl. Syn. des Arches, p. 40, No. 212, 1849.
 — — *D'Orb.* Prod. de Paléont., t. ii, p. 390, No. 1059, 1850.
 — — *Pictet.* Traité de Paléont., t. iii, p. 551, 1855.
 — — *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 905, pl. 68, figs. 23—26, 1858.
 — *ELEGANS.* *S. Wood.* Lond. Geol. Journ., p. 3, 1846.
 — *PRÆTENUIS.* *Charlesworth.* MS. Nat. Hist. Soc. Illust.

Spec. Char. *A. testá* minutá, glabrá, tumidá, ovato-subquadrangulari vel subtrapeziformi, subæquilaterali; pedi-regione latè semicirculari; siphoni-regione paulo minore, angulatá vel obliquè truncatá; umbonibus acutis, distantibus; margine integro, dentibus in medio interruptis; fossulá in arcá cardinali excavatá.

Shell small, glossy, ovately quadrate or slightly trapeziform; subequilateral, subequivalve, tumid; pedilateral margin rounded; siphonilateral truncated or angulated; beaks distant; margins smooth; triangular depression in cardinal area.

Length, $\frac{1}{10}$ th inch; *height*, $\frac{1}{15}$ th of an inch.

Localities. Barton, Bracklesham (*Edwards*), Isle of Wight (*Charlesworth*).

France. Grignon, &c., Calcaire grossier (*Desh.*).

This elegant little shell is by no means rare in England, and specimens present considerable variation.

I have obtained it also from a small patch of the so-called Upper Marine, which intervenes between the true freshwater deposits at Hordle.

There is a peculiarity about this and one or two other species hitherto included in the genus *Arca* which will entitle them to be placed in a distinct section, perhaps to be regarded as forming a distinct genus; they present the same difference from *Arca* that *Limopsis* does from *Pectunculus*, having a portion of connexus placed in a triangular pit immediately beneath the umbo.

M. Deshayes has figured and described two species with this peculiarity in the connector, viz., *A. lævigata* and *A. effossa*, the latter differing from the former in having the exterior surface more distinctly cancellated, while the former is described as being quite smooth, as the name imports. Our little shell corresponds in outline, and pretty well so in magnitude and relative proportions, with both these species, but it does not correctly agree with either in the ornamentation, except that there are a few more prominent rays over the angular ridge on the siphonal region; it has the exterior cancellated, though in a fainter or minor degree than *A. effossa*, but it is not smooth in perfect specimens. This, M. Deshayes remarks, is the smallest known species of the genus, and it is not quite equivalved, the right valve being slightly the larger of the two. It approaches closely to *Trigonocælia*, and might be called *Trigonodesma*.

Since my Plate was engraved, I have seen in Mr. Prestwich's cabinet a small *Arca* found by himself at Shapley Heath, and mentioned in the 'Journ. of the Geol. Soc.,' 1847, p. 390, as an undescribed species. This shell strongly resembles the above, and as Mr. Prestwich considers the deposit in which it is found as belonging to the Bracklesham series, it must, for the present at least, have the same name: it does not, however, satisfactorily conform to the characters of the Barton shell, neither to the specimens found at Bracklesham; in those shells the pedal region is decidedly the larger of the two, and is longer and more elevated; the whole shell is also shorter and more tumid. The Shapley Heath specimens are comparatively longer, and the pedal side is the shorter; the hinge-area also appears to have fewer and larger denticles, and the exterior, so far as can be observed, is quite smooth. I feel unwilling to make another species of it from want of better materials, but I think it must at least be considered as a variety.

11. *ARCA LYELLI*? *Deshayes*. Tab. XV, figs. 12, *a, b*, and 13, *a, b*.

ARCA LYELLI. *Desh.* Coq. Foss. des Env. de Par., t. i, p. 200, pl. 34, figs. 9—11, 1824.

— — *Id.* An. sans Vert. du Bass. de Par., t. i, p. 873, 1859.

Spec. Char. *A. testá elongatá, subcylindracedá, gibbosulá, inæquilaterali, plus minusve irregulari, sulcatá aut radiatim costulatá et concentricè squamoso-lamellosa vel tuberculósá; siphoni-regione longiore angulatá aut obliquè truncatá; umbonibus minimis, depressis, obliquis; areá connexús angustá, dentibus medianis irregularibus; marginibus crenulatis.*

Shell transversely elongate, subcylindrical, slightly tumid, inequilateral, more or less irregular in outline, covered with radiating and rounded ridges decussated by lamellated lines of growth; siphonal region the longer, and obliquely truncated; umbones depressed; area for connector small, narrow; margins crenulated.

Length, $\frac{5}{8}$ ths of an inch.

Localities. Barton (*Edwards*), Colwell (*H. H. Wood*).

This species seems to be rare in our Eocene beds. A few specimens from Barton are in Mr. Edwards's cabinet, and the Rev. H. H. Wood has kindly sent me a specimen from Colwell Bay.

The shell from the French beds, to which this is with some slight doubt referred, is said to be variable; and M. Deshayes has proposed two new species, *A. contorta* and *A. lamellosa*, which he thinks, however, may be ultimately united to *A. Lyelli*, and I am inclined to the same opinion. The shell represented by fig. 13 of our Plate, which I at first imagined to be distinct, may perhaps be referred to *lamellosa*, and that by fig. 12 to *contorta*; these all so closely accord with *A. clathrata*, that I am doubtful whether the Touraine shell be anything more than a variety induced by difference of conditions. Among the few English specimens that I have seen, there is considerable variation; in one the dental area has only a few large teeth, in another of the same size this margin is studded

with double the quantity of denticles; in some the margin is crenulated all round, in others the central portion appears to be free from crenulations, and in *A. contorta* the margin is said to be smooth; this variation is perhaps dependent upon the state of preservation of the specimens. The surface of our shell is covered with rounded rays more or less broad or numerous, and these rays generally project at the margin, particularly on the siphoni-lateral region; this is more especially the case in the shell fig. 12, where the diagonal or carinal ridge is prominent, and the rays are more distinctly lamellated. The position of the umbo is not a permanent character, some specimens being more inequilateral than others.

12. *ARCA MODIOLIFORMIS*, *Deshayes*. Tab. XIV, fig. 5, *a, b*.

<i>ARCA MODIOLIFORMIS.</i>	<i>Desh.</i>	Coq. Foss. des Env. de Par., t. i, p. 214, pl. 32, figs. 5, 6, 1824.
—	—	<i>Id.</i> An. sans Vert. du Bass. de Par., t. i, p. 896, 1858.
—	—	<i>Potiez et Mich.</i> Gal. de Douai, t. ii, p. 111, No. 16, 1844.

Spec. Char. *A. testá elongato-obliquá, ovatá vel irregulariter trapeziformi, valdè inæquilaterali, modioliformi; radiatim striatá, striis in siphoni-regione depressis, undulatis distantioribus; cardine in medio edentulo.*

Shell elongately oblique, ovate or irregularly trapezoidal, very inequilateral, radiately striated, the striæ on the siphonal region somewhat undulating and distant; hinge-line without denticles in the centre, with a few only at each extremity.

Length, 1 inch; *height*, $\frac{7}{16}$ ths of an inch.

Localities. Stubbington (*Edwards*).

France, Cuise-Lamothe, Valmondois (*Deshayes*).

This is apparently a tolerably well-marked species. I have seen only three British specimens; these correspond so well with the Continental shell, that I think there will be no dissent from the identification.

M. Deshayes gives two varieties of his species in his first work, but in his more recent one he has separated what were formerly included under the above name. Our shell appears better to agree in form and in the exterior ornament with what he has called *A. Rigaultiana*; but the ligamental area is narrower, neither has the British fossil so many denticles. Old shells will often have the area of connexus enlarged, but the central portion of the dental area in that case has the denticles obliterated, somewhat after the manner of those in *Pectunculus*.

13. *ARCA NITENS*, *J. Sowerby*. Tab. XV, fig. 5 *a, b*.

<i>ARCA NITENS.</i>	<i>J. Sow.</i>	Trans. Geol. Soc., 2nd ser., vol. v, p. 136, pl. 8, fig. 9, 1834.
—	—	<i>Prestwich.</i> Geol. Journ., 1847, p. 401.

Spec. Char. *A. testá elongatá, obliquá, subtrapezoidali, convexá, tumidá, lævigatá*

glabrâ, valdè inæquilaterali; pedi-regione brevi, rotundatâ, siphoni-regione altiori, subcuneiformi vel obtusè angulatâ; umbonibus prominulis; marginibus integris.

Transversely oblong, convex, smooth, and glossy; pedal region the shorter; siphonal region obtusely wedge-shaped; front oblique; shell thin; beaks slightly prominent; inner margin of valves smooth.

Length, $\frac{1}{2}$ inch; *height*, $\frac{5}{16}$ ths of an inch.

Localities. Hampstead (*Wetherell*), Primrose Hill (*Edwards*).

"Some specimens have a few punctures, in which character they approach *A. impolita*."—*Sow.*

This species is not quite so abundant as *A. impolita*, which it much resembles. The difference which appears to have caused the separation is a little more obliquity in the siphonal region of this species. The ventral margins appear to be free from crenulations, or at least, if they possessed them, they were very small and fine, and there is no sinuation for a byssus. The punctures spoken of by Mr. Sowerby arise from the want of continuity in the smoothness of the outer coating by which the radiating lines are seen distinctly separated, showing punctures or depressions between them and the decussating lines of growth.

14. ARCA PLANICOSTA, *Deshayes*. Tab. XIV, fig. 2, *a, b*.

ARCA PLANICOSTA. *Desh.* Coq. Foss. des Env. de Par., t. i, p. 204, pl. 32, figs. 1, 2, 1824.

— — *D'Orbigny.* Prod. de Paléont., t. 2, p. 390, No. 1047, 1850.

— — *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 878, 1858.

BYSSOARCA DUPLICATA. *J. Sow.*, in *Dixon's Geol. of Suss.*, p. 93, pl. 3, fig. 22, 1850.

Spec. Char. *A. testâ elongatâ, subcylindraceâ, convexiusculâ, inæquilaterali, tenui, in medio depressiusculâ; siphoni-regione valdè longiore, obtusè angulatâ; pedi-regione convexâ, marginibus ventrali et dorsali subparallelis; radiatim costellatâ costellis sæpius planulatis, bifurcatis, aliquando granulatis; umbonibus depressis areâ ligamenti angustâ; dentibus in medio minimis, utrâque extremitate obliquis.*

Shell elongate, subcylindrical, inequilateral, siphonal region much the longer, central portion depressed; pedilateral margin convex, siphonilateral margin obtusely angulated, dorsal and ventral margins nearly parallel; radiately costated with flattened and sometimes divided rays; umbones depressed, ligamental area narrow; teeth small in the centre, inclining towards each extremity.

Length, 2 inches; *height*, 1 inch.

Localities. Bracklesham, Bramshaw, Brockenhurst, Brook (*Edwards*).

France, Senlis, Parnes, Valmondois, Auvers, Le Fayel (*Deshayes*).

This is by no means rare at any of the localities cited, but I have not seen it from Barton. It appears to correspond with the Paris Basin shell of the above name, and it

is closely allied to *A. barbatula*; it differs from the Barton *A. appendiculata* in being more elongated and less inflated, and the siphonilateral margin is more rounded, less angular, and not so much produced. The rays also are more prominent in *appendiculata*, and the lines of growth more distinct, giving to that shell a more elaborate ornamentation; it has also a larger or broader ligamental area; the extremity of the hinge-line on the pedal side is more angular, and there is a difference in the dentition. This species also appears to attain to larger proportions. The only variation that I can detect between the English shells and the French species, to which they are referred, is that the rays upon the siphonal region of the English shells are not quite so broad as upon those from the Paris Basin. The margin of the interior of our shell is slightly and irregularly denticulated. Considerable variation exists among specimens in regard to proportional dimensions, more particularly in those from Huntingbridge; in some the height is equal to three fifths of the entire length, but in others the shell is very cylindrical, with a height not equalling half the length.

In the list of fossils from the Eocene deposits of this country, given by Mr. Prestwich in his paper on the London Clay, published in the 'Journal of the Geol. Soc.,' vol. iii, p. 401, is the name of *A. barbatula*, as from Barton and Bracklesham. I have not seen a specimen from any of our British deposits that can be safely referred to that species; the nearest approach to it are some of the elongated specimens of this species from Huntingbridge.

15. *ARCA TEGULATA*, *Edwards*, MS. Tab. XV, fig. 10, *a*, *b*.

Spec. Char. *A. testá elongatá, subcylindraccá, depressá, lucidá, tenui, inæquilaterali; obsoletè costatá concentricè decussatá; pedi-regione sub-attenuatá, siphoni-regione paulo dilatatá, umbonibus minimis, remotis, prominulis; areá connexús angustá, lanceolatá, lævigatá; dentibus —?*

Shell elongate, somewhat cylindrical, depressed, glossy, thin, and inequilateral; obsoletely or lightly rayed, and decussated by lines of growth; siphonal region a little the broader; umbones small, remote and prominent; area for ligament narrow and smooth.

Length, $\frac{3}{4}$ ths inch; *height*, $\frac{1}{4}$ th inch.

Locality. Bracklesham (*Edwards*).

This appears to be intermediate in form between *A. angusta*, Desh. ('Coq. foss. des Env. de Par.,' t. 1, p. 201, pl. 32, figs. 15, 16), and *A. lucida*, Desh. ('An. s. vert. du Bass. de Par.,' t. 1, p. 891, pl. 67, figs. 26—28), it is nearer to the latter, but it is not so broad in the siphonal region. Ours is an elegantly formed shell, and the only specimen I have seen which has the two valves united is the one figured. The surface is ornamented with rays irregularly distant; those on the pedal region are narrow and close, increasing in size as they approach the siphonal region, where they are broad and flat with a narrow line between them; these are crossed by a broad flat ridge of growth, which is smooth,

and it imparts a gloss or polish to the exterior like that of *A. lucida*. The dental area of our shell appears to be well furnished with teeth, and there is a slight sinuation in the ventral margin.

16. *ARCA TESSELLATA*, *Fisher*, MS. Tab. XV, fig. 14, *a*, *b*.

Spec. Char. *A. testá crassá, elongatá, ovato-oblongá, depressá, sub-obliquá, inæquilaterali; siphoni-regione angulo decurrente definitá; sulcis quatuor crassis, granosis ornatá; umbonibus depressis, obliquis; arcá connexús obliquá, sulcatá, arcá cardinali arcuatá in medio edentulá, ad extremitatem pauci-dentatá; margine ventrali sinuoso, integro.*

Shell elongate, of an ovately oblong form, depressed, slightly oblique, inequilateral; siphonal region with an angular elevation, ornamented with four thick rays; beaks depressed, oblique; area of connector narrow, oblique, and ridged angularly; dental area slightly curved, with few teeth at the extremities, central portion plain; ventral margin sinuated, edges plain.

Length, $1\frac{3}{4}$ inch; *height*, $\frac{7}{8}$ ths of an inch.

Localities. Brook (*Fisher*), Huntingbridge (*Edwards*).

This appears to be closely related to two or three species found in the Paris Basin, but with no one of which does it accord so as to be satisfactorily regarded as an identity. It is not far removed from *A. rudis*, Desh. ('Coq. foss. des Env. de Par.,' t. 1, p. 210, pl. 33, figs. 7, 8), but the rays and decussating ridges of that species are larger and coarser than they are on our shell, and the dental area is different. *A. Morieri*, Desh. ('An. vert. du Bass. de Par.,' p. 874, pl. 65, figs. 18, 19), also resembles our shell, but it has a less prominent and less distinctly marked angular ridge, running from the umbo diagonally across the siphonal region. The rays which ornament our shell are broad and flat, separated by a deep and narrow depressed line, decussated by distinct lines of growth, which imbricate the rays on the larger side. The adductor-muscle-marks are large, particularly the oral one, and the mantle-mark is not very near to the margin of the shell; there is also a long pedal-muscle-mark under the dental margin on the siphonal side. The teeth of our specimens are not in very good condition, but they appear to have been numerous, and those on the pedal side are slightly inclined. There is a sinus or indenture in the margin for a byssus, and the siphonal region is broader or higher than on the pedal side.

A fossil apparently identical with this species has recently been obtained at Lattorf, Magdeburgh, by Herr A. von Koenen, in a deposit of the Upper Eocene (or in what is called by the German geologists Oligocene) period. The German specimens are, however, much larger than our own. One perfect individual measures three and a half inches, and a fragment of the same species indicates a length of nearly five inches.

17. *ARCA TUMESCENS*, *Edwards*, MS. Tab. XV, fig. 1, *a*, *b*.

Spec. Char. *A. testá mediocri, subquadrangulari, sub-inæquilaterali, æquivalvi, gibbosâ vel tumidâ; radiatim tenuissimè striatâ et concentricè decussatâ, politâ; siphoni-regione longiore, vix latiore; marginibus dorsali et ventrali subparallelis, umbonibus approximatis, depressis; areâ cardinali angustâ.*

Shell of moderate size, subquadrangular, slightly inequilateral, equivalve, gibbous or tumid, finely radiated, and decussated by slender concentric lines of growth, glossy; dorsal and ventral margins nearly parallel; beaks small or depressed, with a narrow ligamental area.

Length, $\frac{5}{8}$ ths; *height*, $\frac{3}{8}$ ths of an inch.

Localities. Clarendon, Brook (*Edwards*).

Mr. Edwards's cabinet contains several specimens of this species, in good preservation, and they appear to deserve a distinct specific name. The shell, in some characters, resembles *A. impolita*, but it is more tumid, more equilateral than that species, and it is also more quadrangular, and it is polished and glossy; the very fine striæ with which it is covered are scarcely visible to the unassisted eye; the lateral margins are roundedly angular, and the siphoni-lateral region is rather the broader or higher of the two. It is a handsome shell, resembling, in some slight degree, our common recent species *A. lactea*.

18. *ARCA WEBSTERI*, *Forbes*. Tab. XV, fig. 11, *a*, *b*.

ARCA WEBSTERI. *Forbes*. Mem. Geol. Surv., 1856, p. 150, pl. 3, fig. 8.

Spec. Char. "*T. parvâ, ovato-oblongâ, modioliformi, transversim sulcatâ, radiatim striatâ, anticè angustiori, posticè latiori, effusâ, sub-carinatâ; striis posticis elevatis, acutis, striis cæteris obscuris; carinâ rotundatâ; cardine interrupto, dentibus prominentibus, distantibus.*"

"A small, depressed, modioliform shell, transversely sulcated and with radiating striæ; the anterior narrow, the posterior part spread out and somewhat carinate; the posterior striæ are elevated and acute."

"The umbones are placed near the anterior margin, and the middle part of the cardinal area is without teeth. The teeth are prominent and distant."—*Morris*.

Length, $\frac{5}{8}$ ths of an inch; *height*, half the length.

Locality. "From the Bembridge series." (*Morris*.)

This is a pretty little species, and appears to be confined to the Upper Eocene Deposits. Its principal distinctions are the form of the siphonal region and the ornament with which it is covered. The shell is rather tumid, and a very obtusely angular ridge or

rounded projection extends from the umbo to the base of the siphonilateral margin; the radiating striæ are close and regular upon the pedal and ventral regions, but upon the dorsal slope of the siphonal region these rays are more than usually distant, and are somewhat nodulous; it is very inequilateral, with a recurved and rather prominent umbo.

CUCULLÆA.¹ *Lamarck*, 1801.

Generic Character. Shell equivalve, inequilateral, trapeziform or subquadrate, ventricose; valves closed and striated; umbones remote, separated by a wide and concave ligamental area; anal muscular impression bounded by an elevated ridge; hinge linear, furnished with a few teeth, generally lateral and oblique, but parallel with the hinge-line at the extremities; connexus ligamental.

The shells of this genus approach so closely to some of the *Arca*, that it is doubtful, in the opinion of several naturalists, if there be any good character by which the two can be generically separated. The principal distinction is its subquadrate outline and inflated form, for many of the Ark shells of the older rocks have their dental apparatus with a very similar arrangement, the lateral teeth being few and oblique, sometimes parallel with the hinge-line. Mr. Lycett proposed a genus under the name *Macrodon* for certain fossils of the Oolitic Formation, in consequence of the hinge-denticles differing somewhat in their number and position; those on the pedal side of the margin being almost at right angles to the hinge-line, while at the opposite extremity they are parallel with it, appearing thus to combine or unite the two genera, *Arca* and *Cucullæa*. The British species, *Arca rari-dentata*, has the teeth much inclined on both sides. Very many fossils have been placed in this genus, beginning as low as the Silurian Rocks and ranging up to the present period; only one living species is known which truly resembles the typical form, and that is an Oriental shell. Some of the fossil species have the umbones inflected in a subspiral manner, but a commencement of this form may be seen in some of the *Arca*.

CUCULLÆA DECUSSATA, *Parkinson*. Tab. XVII, fig. 8, *a—c*.

CUCULLÆA DECUSSATA. *Park.* Org. Rem., vol. iii, p. 171, t. xiii, fig. 1, 1811.

— — *J. Sow.* Min. Conch., t. 206, figs. 3, 4, 1818.

— CRASSATINA. *Morris.* Catal. Brit. Foss., p. 197, 1854.

— — *Prestwich.* Quart. Journ. Geol. Soc., 1854, p. 109.

Spec. Char. *Testâ transversâ, ovato-oblongâ, gibbosâ, incrassatâ, obliquâ, inæquilateralî, decussatim striatâ, in medio compressiusculâ; pedi-regione brevi, obtusâ, siphoni-regione*

¹ *Ety.* Cucullus, a hood. Type, *Arca cucullus*, Linn.

subangulata; *area connexus angusta*; *sulcis raris excavata*; *marginibus denticulatis*; *dentibus lateralibus tribus*.

Shell transverse, ovately oblong, inflated, thick, oblique, and inequilateral, striated and decussated, slightly compressed in the middle of the shell; pedal region short; ligamental area rather narrow, with few and obsolete chevron-form marks; margins denticulated, three lateral teeth on each side.

Length, $2\frac{1}{2}$ inches; *breadth*, $1\frac{1}{2}$ inch.

Localities. Faversham (*Crowe*), Herne Bay, Richborough, Oakwell, near Faversham, Nash Park, near Boughton (*Prestwich*).

This shell is considered by Professor Morris, in his 'Catalogue of British Fossils,' as identical with *Cucullæa crassatina*, Lamk.; but, although there is a very close approximation, I am doubtful of their identity; and, as I am not imposing a new name, I prefer the British fossil should remain with the one under which it was figured and described by Parkinson and Sowerby.

On a comparison of the English shells with specimens in my own cabinet from Beauvais, I find the following differences:—The French shells appear to be more inflated, and they have a more prominent, angular, and distinct ridge diagonally across the syphonal region, and the English shells are comparatively longer; neither can I see the great inequality between the two valves which is so conspicuously shown in the French specimens; the rays upon our shell are large, wide, flat, and bipartite, and these rays are more nearly alike upon the two valves than are those of *C. crassatina*. The dental area is furnished with a few teeth at each extremity of the line; those on the syphonal side are about three or four in number, and parallel with the hinge-margin; at the opposite extremity there are about the same number, and they are also inclined; all of them are vertically striated, or rather denticulated, but more finely so than are either of the French species, and in the centre of the hinge-line are a few small teeth in a vertical direction; these are also finely nodulous; the margin is crenulated by the outcrop of the rays.

PECTUNCULUS, *Lamarck*, 1789.

Gen. Char. Shell equivalve, orbicular, convex, or lenticular, nearly equilateral, smooth, or radiately striated; umbones central, generally distant, divided by a striated area for connexus, which is wholly external or ligamental; hinge with a curved row of transverse or angular denticles; adductors nearly equal, pallial line simple, margins crenulated; the shells in the living state are generally covered by a thick and velvety epidermis.

Animal with the margins of the mantle simple, sometimes studded with minute ocelli; foot large, crescent-shaped, capable of considerable expansion, so as to form a disc, on which it is said to be able to move; this foot is supplied with retractor-muscles, the im-

pression of which may be generally seen, one on each side and above the adductors, within the extended dental margin.

Although the mantle is generally open all round, the animal is capable of contracting or uniting the edges on one side, so as to form two openings, one for the incoming current and the other for the outgoing, being the commencement of the true siphons.

The known recent species of the genus are about sixty or seventy, and perhaps a similar number in the fossil state; these last are very difficult of determination, from the generally slight deviations in the form of the shell, the normal condition being nearly lenticular, the specific distinctions depending principally upon the sculpture of the surface or dental characters; but these teeth are very fallacious, as some are obliterated by age.

The peculiar form of these shells are favorable to their preservation, offering, as they do, a protection from mutilation, and specimens are often in high perfection.

The genus, in the recent state, has a wide geographical extension, but the species are somewhat restricted in their range; they are principally inhabitants of warmer regions, although *P. glycimeris* is living in the British seas, and *P. septentrionalis* in those of the north-west coast of America. A species found in the Eocene deposits of North America is said to be identical with one of our own fossils of the same age. It is most difficult, as before observed, to determine identity in shells of this genus; but, assuming it to be as so stated (which I much doubt), we may, I think, fairly place this species in the same category as *Terebratulina caput-serpentis*, *Kellia suborbicularis*, and many other living molluscs, whose localities at the present day are separated by apparently impassable barriers. We are not able now to trace these animals, whose localities are so unconnected, to what may be assumed as a common ancestry for each species thus identified. Whether these apparently identical forms are descendants of ancestors belonging to the same species once living together in close geographical contiguity, or whether they are forms having a distinct origin, but presenting no difference by which the malacologist can separate them from the typical species, we have at present not the materials to determine.

1. PECTUNCULUS BREVIROSTRIS, *J. Sowerby*. Tab. XVI, fig. 8.

PECTUNCULUS BREVIROSTRIS. *J. Sow.* Min. Conch., t. 472, fig. 1, 1824.

— — — *Id.* in Dixon's Geol. of Suss., p. 225, t. 14, fig. 32, 1850.

— BREVIROSTRUM. *Morris.* Catal. Brit. Fos., p. 219, 1854.

— PULVINATUS. *Mantell.* Geol. of Suss., p. 273, 1822.

PECTUNCULUS. *Smith.* Strata Identif., t. 11, fig. 3, 1816.

Spec. Char. *P. testá suborbiculari vel obovatá, convexo-lenticulari vix inæquilaterali, sub-symmetricá; radiatim obsoletè costellatá; concentricè striatá; umbonibus brevibus depressis; areá connexús magná, areá dentali arcuatá; dentibus paucis magnis; marginibus crenulatis.*

Shell suborbicular, slightly ovate, tumidly lenticular, nearly equilateral and symmetrical; covered with obsolete radiating ridges, and concentrically striated; beaks short or depressed; area of the connector large, dental margin curved, teeth few and large; margins crenulated.

Diameter, 2 inches.

Localities. Bognor (*Sowerby*), Reading (*Morris*).

This is a long and well-known shell at Bognor, where it has been found in abundance, with the valves generally united, and their ventral margins closed; the area for the ligament is rather wide, and ornamented with about half a dozen diverging depressed lines, and these oftentimes bear vertical striæ, the impression of the linear composition of the ligament. The radiating rays of the exterior are broad and depressed, separated only by a thin, narrow line.

2. PECTUNCULUS DECUSSATUS, *J. Sowerby*. Tab. XVI, fig. 7 *a—d*.

PECTUNCULUS DECUSSATUS. *J. Sow.* Min. Conch, t. 27, fig. 1, 1812.

— — *Id.* in Dixon's Geol. of Suss., p. 116, t. 14, fig. 7, 1850.

— — *Smith.* Strata. Identif., t. 11, fig. 10, 1816.

Spec. Char. *P. testá suborbiculatá vel obtusè et irregulariter quadrangulari, æquilaterali, tenui, depressiusculá; radiatim costellatá, concentricè striatá, decussatá; areá connexús bipartitá; areá dentali arcuatá, multidentatá; umbonibus acutis; marginibus integris.*

Shell suborbicular or obtusely and irregularly quadrangular, equilateral, thin, and somewhat depressed; radiately striated, and decussated by lines of growth; area of the connector bipartite; dental margin curved and well filled with teeth; beaks sharp, margins smooth.

Length, $\frac{9}{16}$ ths; *height*, $\frac{5}{16}$ ths of an inch.

Localities. Highgate (*Wetherell*), Bognor (*Dixon*), Basingstoke (*Prestwich*), Clarendon, Haverstock Hill (*Edwards*).

This is abundant at Highgate, and Mr. Sowerby has figured a specimen from Bognor, where, I believe, it is rare. The specimens from Highgate are generally in a good state of preservation except at the umbones, nine tenths at least are there broken. The outline of this species is more quadrangular than in the generality of the genus, especially at the siphonilateral margin, and the shell is rather longer than it is high. The surface is prettily ornamented by the lines of growth, decussating the rays, by which they are made slightly nodulous; the radiating lines are occasionally distant, with one to three intermediate or smaller rays. The radiations of the mantle are generally impressed upon the interior of the shell, and the impressions of the adductors are very large. The area for the connector is somewhat peculiar, having a large obtusely angular depression, and it is bipartite, like that of *Limopsis*; this depressed ligament is strongly marked with lines at right

angles to the dental margin (fig. 7, *c*, *d*), showing the linear fibres of which it is composed, these being the more durable portion, are alone remaining. Fig. 14, Tab. XIX, is the representation of a young individual from Clarendon; it is of a rather more elongated form than the generality of the larger specimens, but its peculiarity is in the area for connexion, where it shows a bipartite character precisely resembling that which is considered a generic distinction in *Limopsis*; in this young shell the triangular cavity is not only small, but it is comparatively much less than in the adult shell. The connexion between the two genera in the immature state appears so close as not to permit of generic separation, showing, as in many other animals, a very near relationship in the early part of life, diverging by the increase of age.

Some of these young shells have the rays upon the exterior fewer and more prominent, resembling those upon *P. deletus*, the intermediate rays being small and scarcely perceptible; they are not peculiar to the Clarendon specimens, but may be seen also on young shells from Haverstock Hill. Casts resembling this species have been found at Sheppey.

3. PECTUNCULUS DELETUS, *Solander*. Tab. XVI, fig. 3, *a*, *b*.

ARCA DELETA. *Solander*, in Brand. Foss. Hanton., p. 97, pl. vii, fig. 97, 1766.

PECTUNCULUS COSTATUS. *J. Sow.* Min. Conch., t. 27, fig. 1, 1813.

— DELETUS. *Morris.* Catal. Brit. Foss., p. 219, 1854.

Spec. Char. *P. testá orbiculatá, convexá, vel regulariter lenticulatá; radiatim costatá; costis æqualibus angustis, acutis ornatá; concentricè striatá; striis creberrimis; costis aliquando tuberculatis; umbonibus subelevatis, recurvis; cardine valdè arcuato, multidentato.*

Shell orbicular, convex, or lenticular, radiately costated; ribs equal, sharp, and narrow; concentrically striated lines of increase numerous, close, ribs sometimes tuberculated; beaks slightly elevated, recurved; hinge-line with numerous teeth.

Diameter, 1½ths of an inch.

Locality. Barton.

This is an abundant shell at Barton. I have not seen it from any other locality.

Some specimens are almost smooth, or at least are covered with only depressed rays, without the appearance of abrasion, others are beautifully ornamented with narrow sharp ribs, varying from twenty-five to thirty-five; and these are, in very well preserved specimens, covered with tubercles produced by the prominent lines of growth. The dental area is well furnished with a continuous line of teeth varying from twenty to thirty. The margin of the valves is regularly denticulated, and these are not the extension of the ribs, but appear to be quite independent.

A shell found by Herr A. von Koenen at Lattorf appears to agree with the smooth variety of this species.

4. PECTUNCULUS GLOBOSUS, *J. Sowerby*. Tab. XVI, fig. 9.

PECTUNCULUS GLOBOSUS. *J. Sow.* in Dixon's Geol. of Sussex, p. 170, t. 3, fig. 20, 1850.

Spec. Char. *P. testá crassá orbiculari, globosá, sub-æquilaterali, æquivalvi, lævigatá, aut obsoletè radiatá; margine cardinali arcuatá, umbonibus prominentibus, marginibus crenulatis.*

Shell thick, obliquely orbicular, globose, slightly inequilateral, equivalve, smooth, with faint or obsolete radiations; hinge or dental area curved; beaks prominent; margins crenulated.

Diameter, 1 inch.

Locality. Bracklesham (*Dixon*).

This appears to be more tumid at the upper part than any other species. There is a resemblance between it and *proximus*, which is common at Barton; but that shell is always more or less oblique, with a sharper or less tumid umbonal region, and this shell, as its name implies, is more globose.

5. PECTUNCULUS PLUMSTEADIENSIS, *J. Sowerby*. Tab. XVI, fig. 6, *a, b*.

PECTUNCULUS PLUMSTEADIENSIS. *J. Sow.* Min. Con., t. 27, fig. 3, 1813.

— — — *Morris.* Catal. Brit. Foss., p. 219, 1854.

Spec. Char. *P. testá tenui, lenticulari vel orbiculato-subquadratá, æquilaterali; obsoletè costatá vel radiatá, concentricè striatá; umbonibus depressis; marginibus crenulatis; areá connexús parvâ.*

Shell thin, lenticular, with a somewhat roundedly quadrangular outline; equilateral, obsoletely costated or radiated; beaks depressed, with a small area for the connector; margins toothed.

Diameter, $1\frac{1}{2}$ inch.

Localities. Plumstead; Upnor; Katesgrove, near Reading.

This is thinner than the generality of the genus, and the rays upon the exterior are broad and rounded; it resembles *brevirostris* in having a small beak, but that shell is more oblique, with the rays less prominent, the hinge less curved, and the denticles fewer. In the 'Geol. Journ.,' vol. x, p. 120, 1854, this species and *brevirostris* are united with *P. terebratularis*, Lamarek. M. Deshayes (p. 852) considers the two latter as distinct, and I am disposed to agree with him, but I believe also that the above-named *Plumsteadiensis* is entitled to a distinct specific position.

6 PECTUNCULUS PROXIMUS, *S. Wood*. Tab. XVI, fig. 5, *a—c*.

Spec. Char. *P. testá obliquè suborbicularè, inæquilaterali, crassá, tumidá; obsoletè costulatá vel radiatá; siphoni-regione subangulato; umbonibus prominulis; areá connexús obtusè triangulari; dentibus numerosis.*

Diameter, $1\frac{1}{8}$ inch.

Locality. Barton (*Edwards*).

This species differs from *P. pulvinatus*, with which it has been hitherto associated, in being more oblique, more elevated, and less tumid, and there is always a greater extension of the siphoni-lateral margin, with a depression or flattened space above a slight ridge, extending from the umbo on that side, particularly in elevated specimens. The shell in general has a greater diameter in the direction of its height, and in these specimens the ligamental area is larger or higher, with the dental margin broader than in others; but its principal distinction is the angular ridge on the siphonal side. Tab. XVII, fig. 11, is from Huntingbridge, and may, I now think, be referred to this species; it was at first supposed to be a *Limopsis*, but the character which induced that name is probably accidental; it is, however, smoother and thinner than the generality of the Barton specimens.

There are two or three species from the Paris basin to which our fossil bears a close relationship, but to no one of them can I satisfactorily assign it. *P. depressus* (Desh.) resembles it in outline, but our shell is neither depressed ("depressissima"), nor thin; it is crenulated all round, not "mince et lisse antérieurement et postérieurement;" neither is the "area ligamenti minima."

7. PECTUNCULUS PULVINATUS, *Lamarck*. Tab. XVI, fig. 2, *a, b*.

PECTUNCULUS PULVINATUS. *Lam.* Ann. du Mus., t. vi, p. 216, and t. ix, pl. 18, fig. 9, *a, b*.

—	—	<i>Desh.</i> Par. Foss., p. 219, pl. 35, figs. 15—17.
—	—	<i>Ib.</i> Coq. Caract. des Terr., pl. 5, figs. 9, 10.
—	—	<i>Bronn.</i> Leth. Geogn., t. ii, p. 936, pl. 39, fig. 4.
—	—	<i>Goldf.</i> Petr. Germ., p. 160, No. 5, pl. 126, fig. 5.
—	—	<i>Nyst.</i> Belg. Foss., p. 250, pl. 19, fig. 8, <i>a, b</i> .
—	—	<i>J. Sow.</i> in Dixon's Geol. of Suss., p. 93, t. 11, fig. 25.
—	—	<i>Bronn.</i> Syst. der Urw., p. 52, pl. 5, fig. 13, 1824.

Spec. Char. *P. testá orbiculatá, ventricosá aut pulvinatá, subæquilaterali viâ obliquatá, striato-costulatá vel radiatá, tenuè decussatá; margine crenato, crenulis brevibus; areá cardinali perangustá, umbonibus depressis.*

Shell orbicular or lenticular, ventricose or puffed up, nearly equilateral, slightly

oblique; radiated or obsoletely costulated, finely decussated; margin toothed, area of connector rather narrow; beaks depressed.

Diameter, 2 inches.

Localities. Stubbington (*Edwards*).

Belgium: Le calcaire d'Afflighem et d'Audenarde, Kleyen Spauwen (*Nyst*).

France: Grignon, Courtaignon (*Deshayes*).

A large number of fossils from various localities and from various formations have been figured and described under the above name; Brongniart has given it to a species from the neighbourhood of Turin, and Dubois to one from Volhynia, but these are, perhaps, not strictly within what are called specific limitations. The principal character, as its name imports, is a tumid or puffed-up appearance of the specimen, with a very slight deviation from the orbicular or rather circular form of the margins. There is also a slight angularity on the siphonal region, as is often the case in shells of this genus. The dental area is curved and well furnished with teeth, and the area for connexus is rather small, but it increases considerably as the shell enlarges, and it is comparatively wider in the old shell, where the ligamental portion of the connector has obliterated or overlapped the denticles in the centre of the hinge area. The surface of the English specimens is seldom or never in such a good state of preservation as those from the Paris basin, where the small interstices between the rays and the lines of growth may be distinctly seen, giving a slightly punctured appearance to the exterior, and in those shells a portion of the connector is often preserved.

8. *PECTUNCULUS QUASIPULVINATUS*, *S. Wood*. Tab. XVI, fig. 1, *a*, *b*.

Spec. Char. *P. testá lenticulato-complanatá, compressá, æquilaterali, æquivalvi, subtransversá; radiato-striatá, striis depressis, obsoletis; concentricè decussatá; marginibus crenulatis; areá connexús perangustá; umbonibus depressiusculis.*

Shell compressed or depressedly lenticular; equilateral, equivalve, rather transverse or elongated; covered with depressed and obsolete striæ; decussated by obscure or irregular lines of growth; margins crenulated; area of connector narrow; beaks depressed.

Diameter, $2\frac{1}{8}$ inches.

Locality. Bracklesham.

This has hitherto been placed in cabinets under the name of *P. pulvinatus*, var., but I think the differences are such as to entitle it to a separate specific position, and the specimens themselves appear to show a permanence of difference which give them as good a claim for isolation as most others in this perplexing genus. Our shell is much more compressed than the true *pulvinatus*, and the proportions in this are also different, the shell being more transverse or elongated. It differs also from the French shell called *pseudopulvinatus*, which is neither so compressed nor so transverse as our present species. I

have separated the two British shells in consequence of the very great difference in the tumidity or convexity displayed between them, and this difference appears to be constant. The Stubbington shell measures $2\frac{1}{8}$ th inches in diameter, with $1\frac{5}{8}$ ths inch in depth or tumidity of the united valves, while the Bracklesham shell is longer than it is high, and it has a depth of less than an inch between the inflation of the two valves. There is also a difference in the hinge; this latter shell has a narrower dental area, with a place for connexus also smaller.

9. PECTUNCULUS SPISSUS, *S. Wood.* Tab. XVI, fig. 4, *a, b.*

Spec. Char. *P. testá spissá, tumidá, globosá, orbiculari, æquilaterali; radiatim obsoletè costellatá, costis depressis; umbonibus prominentibus; areá connexús elongato-trigonatá, profundè sulcatá; margine dentali crassá, dentibus quatuor ad quinque, utroque latere transversalibus crassiusculis; marginibus irregulariter crenulatis.*

Shell thick, tumid, globose, orbicular, equilateral, with depressed and obsolete ribs; beaks prominent, area of connector broadly triangular, with deep chevron-formed lines; dental margin thick, with 4 to 5 teeth on each side, inclining towards the extremities; interior margins irregularly crenulated.

Diameter, $1\frac{1}{4}$ inch.

Locality. Southampton (*Edwards*).

This species, I believe, is not rare; I have seen it only from one locality, and the specimens appear to be nearly all of the same magnitude, as if the full-grown shell, which I presume it to be, did not exceed the above dimensions. I have ventured to propose for this a new specific name, considering the characters to differ from those of any other species. The nearest to which it approaches is *P. globosus* of the Bracklesham beds, but from which it appears to differ in having a more prominent umbo, and that shell has a more thickened dental area, with fewer teeth.

10. PECTUNCULUS TEREBRATULARIS, *Lamarck.* Tab. XVI, fig. 10.

PECTUNCULUS TEREBRATULARIS. *Lamk.* Ann. du Mus., t. vi, p. 217, No. 3.

— — — *Desh. Coq. foss. des Env. de Par.*, t. i, p. 221, pl. 35,
figs. 10, 11, 1829.

Spec. Char. “*P. testá orbiculatá, subæquilaterá, ventricosá, cordatá, incrassatá, radiatim sulcatá, sulcis planiusculis decussatis, cardine lato paucidentato; dentibus lateralibus striatis.*”

Shell orbicular, nearly equilateral, ventricose, heart-shaped, thick, covered with radiating

striae or depressed riblets decussated by lines of growth ; hinge-area broad, with few teeth, lateral denticles striated.

Diameter, 2 inches.

Localities. Herne Bay (*Edwards*), Upnor (*Prestwich*).

France: Les environs de Soissons, près d'Etampes, &c. (*Desh.*).

The most distinguishing character in this species is a prominent or rather recurved umbo, somewhat resembling the beak of a *Terebratula*, which, I presume, suggested the name to Lamarck.

Fig. 10, Tab. XVI, represents a shell that was some years since obligingly given to me by Professor Morris, and it had the locality of Ilford attached to it, but that gentleman is now unable to state from what bed it was derived. It was accompanied by a *Cytherea* from the same locality, and this latter species I have since obtained from the Woolwich beds underlying the London Clay, reached in a well-sinking at Romford. There is therefore every probability that our specimen came from the same bed at Ilford. I am unable to assign this specimen to any species known to me, unless it might perhaps be referred to *brevirostris*, but with which it does not strictly accord. *P. polymorphus* also much resembles it.

A shell from the Paris Basin has been figured and described under the name *P. paucidentatus* (*Desh.*), 'An. sans Vert. du Bass. de Par.', t. i, p. 852, pl. 73, f. 16, 17, which has the locality of Woolwich attached to the description. I have not been able to find any British specimen entitled to that distinction.

LIMOPSIS, *Sassi*, 1827.

Gen. Char. Shell orbicular or slightly oblique, convex or lenticular, equivalved, sub-equilateral, closed ; hinge with two slightly curved and slightly unequal series of projecting and interlocking teeth ; umbones distant ; connexus ligamental, bipartite, one portion inserted in a triangular cavity immediately beneath the umbo ; impression of the mantle entire.

The animal of one species of this genus (*L. aurita*) has lately been obtained in the seas of North Britain by Mr. Jeffreys, the account of which has been published in the 'Ann. and Mag. Nat. Hist.,' 1862, and he says "the body is of a milk-white colour. The mantle is open at every part except behind ; it has no folds or tubes, and its edges are thickened and furnished with papilliform glands. The foot is large in proportion to the rest of the body, and it is shaped like a tobacconist's knife ; it can, in all probability, form a suboval disc at the central portion, as in *Pectunculus*." It so much resembles that genus that the only distinction on which a separation can be founded is the triangular fossette in the area for connexus, and this cannot be considered a very important one, as it is present upon the young shell of *Pectunculus decussatus*.

Some Eocene fossils have been figured and described by MM. Nyst, d'Archiac, and Bellardi, under the generic name of *Stalagmium*, strongly resembling aberrant forms of this genus; they differ, however, slightly in the dental area, the central portion being much broader than in *Limopsis*, where the triangular fossette has pushed forward the ligamental connector, so as to diminish materially the dental line beneath the umbo. In those shells called *Stalagmium* there is an absence of the external triangular fossette, the connector being situated in a linear depression on one side only of the umbo, differing also in that respect from *Pectunculus*, which it otherwise somewhat resembles; the ligamental area is ridged or furrowed like most of the shells of this family. If these differences be considered sufficient to constitute generic distinction, those shells must be denominated *Stalagmium*, Nyst, as the genus proposed by Messrs. Lea and Conrad is untenable for the American Eocene fossil, which, as before stated, is a species of *Modiola* or *Crenella*.

I. LIMOPSIS GRANULATA, *Lamarck*. Tab. XVII, fig. 10, *a*, *b*.

PECTUNCULUS GRANULATUS.	<i>Lamk.</i>	Ann. du Mus., t. vi, p. 117, No. 4, and t. xi, pl. 18, fig. 6, <i>a</i> , <i>b</i> .
—	<i>Desh.</i>	Coq. foss. des Env. de Par., t. i, p. 227, pl. 35, figs. 4—6, 1829.
LIMOPSIS	—	<i>Prestwich</i> , Geol. Journ., 1847, p. 404.
—	<i>J. Sow.</i>	in Dixon's Geol. of Sussex, pp. 93, 170, t. 3, fig. 19.
—	<i>Desh.</i>	An. sans Vert. du Bass. de Par., t. i, p. 842, 1859.

Spec. Char. Testâ orbiculatâ, lenticulari, convexâ; subæquilaterali; decussatim striatâ; striis longitudinalibus angustioribus granulosis; cardine recto, umbonibus minimis; marginibus obsoletè crenulatis.

Shell orbicularly lenticular, convex, slightly inequilateral, striated or radiated and decussated; radiations fine and granular; hinge straight, umbones small, depressed; margins obsoletely or irregularly crenulated.

Diameter, $\frac{1}{2}$ an inch.

Localities. Bracklesham (*Edwards*).

France: Grignon, Parnes, Senlis (*Deshayes*).

This is a rare species in England, and found only at the above locality; it is said to be abundant in the Paris Basin.

The surface of this shell is covered with fine, small, radiating striæ, which are crossed or decussated by prominent lines of growth; the conjunction of these two lines causes an elevation, thus giving a granular surface to the exterior; the shell is nearly lenticular and equilateral, the diameter being, as near as possible, the same in each direction, though occasionally it is a trifle in excess in the height. The hinge is furnished with three to five denticles on one side of the umbo, nearly vertical, and on the other from five to six in a curving direction, and the interior margin is faintly and somewhat irregularly denticulated.

The upper part of the hinge-line is nearly straight, which gives a small shoulder to the shell on each side. *Trigonocælia granulata*, Nyst, 'Coq. foss. Belg.,' p. 241, pl. 19, fig. 1, strongly resembles our shell by figure and description; but M. Deshayes, who, I presume, has examined the Belgian fossil, says it is specifically different. The artist has given rather too much obliquity to our figure.

Limopsis Belcheri, Adams and Reeve, is said by Mr. Jeffreys, 'Ann. and Mag. Nat. Hist.,' 2nd ser., vol. x, p. 345, Nov., 1862, to be the same as the Eocene species.

2. *LIMOPSIS SCALARIS*, *J. Sowerby*. Tab. XVII, fig. 9, *a*, *b*.

PECTUNCULUS SCALARIS. *J. Sow.* Min. Conch., t. 472, fig. 2.

— — *Morris.* Catal. Brit. Foss., p. 207, 1854.

Spec. Char. *Testâ orbiculatâ, convexâ, inæquilaterali obliquâ; radiatim costulatâ, et concentricè striatâ, decussatâ; costulis granularis, angustis, separatis; cardine obliquo; umbonibus parvis; marginibus crenulatis.*

Shell orbicular, convex, inæquilateral, oblique, radiately costulated and decussated by lines of growth; rays rough, subgranular; hinge oblique; umbones small; margins crenulated.

Diameter, $\frac{5}{8}$ ths of an inch.

Locality. Barton.

This is an abundant shell at Barton, where the two valves are often found united. The exterior of this species is prettily ornamented with about twenty-four or twenty-six prominent rays, or rather acutely angular costæ, with often an intermediate ray, sometimes two; these rays are cut or crossed by prominently rounded ridges of growth, which decussate the surface, and produce a nodulous appearance on the rays, like the exterior of *Pectunculus deletus*. "The transverse lines between the ribs resemble the steps of a rope-ladder."—*J. Sowerby*. The hinge-margin is furnished with about five to eight prominent teeth, placed at nearly right angles to the hinge-line on the pedal side, and about nine to twelve in a curving direction on the other. The interior of the entire margin is irregularly denticulated, but not at the extreme edge. The triangular fossette in the area of connexus is large and deep, diverging from the umbo at nearly a right angle.

TRIGONOCÆLIA. Deshayes.

Generic Character. Shell equivalve, generally small, inequilateral; more or less trigonular or deltoidal; pedi-lateral margin rounded, siphoni-lateral angular; umbones prominent, ventral margin smooth; hinge-line divergent, with sharp and generally angular

and prominent denticles, divided into two portions; connexus ligamental, placed in a triangular fossette; two adductor-muscles; impression of mantle without a sinus.

The connector being situated entirely on the outside of the dental apparatus, concentrated in a triangular cavity and opening the valves by contraction, is a sufficient character to entitle these shells to be placed in a distinct generic position. This triangular fossette bears a resemblance to that upon *Limopsis*, but there is no extended area or bipartite division of the connector, as in that genus.

M. Nyst proposed the name *Trigonocælia* for those bivalves which resembled *Pectunculus*, but differed in the disposition of the connector, as before remarked. *Trigonocælia*, therefore, from want of priority, had lapsed into a synonym. M. Deshayes has employed the above name for his genus, as the type species had been called *Trigonocælia* by M. Nyst.

The present genus is an emanation from *Limopsis*, differing from it by the loss of the expanded ligamental area, approaching closely to *Leda* in the form of the shell. The animal is at present unknown, but from its pointed siphonal region it probably possessed incipient siphons.

A few species only of this genus have been described; six of these are from the Paris Basin, and one has been figured by Mr. Lea from the Eocene deposits of America; these, with the British species, are all confined to the older Tertiaries. The animals appear to have been capable of firmly closing their valves; they have large and well-marked impressions of the adductors.

1. TRIGONOCÆLIA DELTOIDEA? *Lamarck*. Tab. XIX, fig. 11, *a—c*.

NUCULA DELTOIDEA? *Lamk.* Ann. du Mus., t. vi, p. 126, and t. ix, pl. 18, fig. 5.

— — — *J. Sowerby.* Min. Conch., t. 554, fig. 1.

LIMOPSIS DELTOIDEA? *D'Orb.* Prod. de Paléont., t. ii, p. 389, No. 1019.

LEDA DELTOIDEA. *Morris.* Catal. Brit. Foss., p. 205, 1854.

TRIGONOCÆLIA DELTOIDEA? *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 840, 1858.

Spec. Char. *T. testá trigoná vel deltoideá, tumidá, crassiusculá, subæquilaterali, concentricè striatá; pedi-regione rotundatá, obsoletè radiatá; siphoni-regione angulatá, et carinatá; umbonibus magnis prominentibus; cardine arcuato, dentibus 5 vel 6 utroque latere; fossulá connexús profundá, triangulari.*

Shell trigonal, tumid, rather thick, nearly equilateral; concentrically striated; pedal region rounded and obsoletely rayed; siphonal region angulated and keeled; beaks large and prominent; hinge-line curved, furnished with 5 or 6 denticles on each side; depression for connector deep and triangular.

Length, $\frac{3}{16}$ ths inch; *height*, $\frac{1}{16}$ th inch.

Localities. Barton (*Edwards*), Hordle (*S. Wood*), Shapley Heath (*Morris*).

This species appears to be restricted to the uppermost deposits; I have not seen it from below the Barton beds. It is not rare, though by no means so abundant as the Paris Basin shell. On comparing the British fossil with the French species, the following differences may be observed. Our shell is shorter, more elevated, and more regularly ribbed in the direction of the lines of growth; the angle on the siphonal region is sharper and more distinct, and there are only small, fine, and very faint rays upon the edge of the pedal region, whereas in the French shell these rays are few, large, sharp, and very prominent. The exterior of our shell has faint radiating lines, only perceptible in very perfect specimens, and by the assistance of a magnifier; they are most distinct on the siphonal region, particularly beyond the angular slope near the siphoni-lateral margin. The number of denticles are fewer in our shell than in the French specimens. It may be called var. *deltæ-formis*.

2. TRIGONOCÆLIA CANCELLATA, *Deshayes*. Tab. XIX, fig. 12.

TRIGONOCÆLIA CANCELLATA. *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 838, pl. 64, figs. 31—35, 1860.

Spec. Char. T. “*testá transversim trigoná, inflatá, subæquilaterali, antice obtusá, postice acute angulatá, striis longitudinalibus, transversalibusque, eleganter decussatá, ad latus anticum longitudinalibus, proeminentioribus, distantioribus; latere postico plano, ovato, angulo, acuto, aliquantisper proeminenti separato, liris tenuibus distantibus ornato; cardine brevi, angusto, paucidentato; dentibus minimis, sæpius complicatis, fossulá ligamenti satis latá, regulariter triangulari.*”—*Desh.*

Shell elongately trigonular, slightly inflated; subequilateral; pedal region the larger, somewhat inflated; pedilateral margin rounded; siphonal region slightly compressed, angular, with pointed termination; exterior radiated and decussated by prominent and regular lines of growth; hinge-area small, denticles few; depression for connexus broadly triangular and shallow.

Length, $\frac{1}{2}$ an inch.

Localities. Huntingbridge.

France: Parnes, Damery-Auvers, Acy, Mary, Caumont, Crouy, La Ferté-sous-Jouare, Le Fayel (*Deshayes*).

A single specimen only of this species has been obtained by Mr. Edwards, and that unfortunately is not quite perfect; a part of the hinge-area has been destroyed, but the exterior and general contour of the shell correspond with the French species, and it may fairly remain with the above name for the present. It is quite distinct from our *deltoidæa*.

NUCULA. *Lamarck.*

Generic Character. Shell ovately trigonal or nut-shaped, smooth, or occasionally sculptured; nacreous, inside iridescent; siphonal region short or truncated; the umbones never prominent; hinge with a row of more or less numerous angular and elevated interlocking teeth; connexus cartilaginous; pallial line simple.

Animal of the shape of the shell; margins of the mantle disconnected all round; foot large, capable of being expanded into a disc, and ornamented with fimbriated edges.

The peculiarity of this genus consists in having the larger portion of the shell on the pedal side, and the umbo pointing in the opposite direction, an arrangement contrary to that which prevails in the generality of bivalves, and also in having the spoon-shaped projection within the hinge-margin, on which is placed the cartilaginous connector on the pedal side of the umbo. The hinge-line forms nearly a right angle, but this diverges into an obtuse one in the aberrant species, where an extension of the shell, on the verge of the genus, approaches the ovate or elongated form of *Leda*.

The animal of this genus, the inhabitant of the shell which is the type, is said not to have any siphons, and that the margins of the mantle are disconnected. In the approximating genus *Leda*, the mantle in the siphonal region is connected so as to form two distinct tubes, which are capable of considerable exsertile extension. The animal of *Nucula* proper has the mantle open all round; but in those species which have an extension on the siphonal side approaching *Leda*, it will probably be found that the margins of the mantle in the siphonal region are partly connected, so as to separate the incoming from the outgoing current.

In this genus the greater number of the fossil species have the interior or ventral margins of the shells ornamented with crenulations. These crenulations are found in those species only in which the exterior of the shell is covered with radiating lines; they are apparently due to the fimbriated edges of the mantle, and do not extend to the edges of the dorsal margins, even where the area of dentition is limited. The ventral margins of the mantle in *N. nucleus* are said to be plain; but I imagine they must be very finely fimbriated, in order to deposit the elevated layers of shelly matter which produce the radiations. These rays are most conspicuous upon the under surface, which is sometimes covered over with a coating of enamel-like material, so as to obliterate or at least to obscure the rays; but when the margins are crenulated, I presume they will always be more or less visible.

The shells of the species which have the margins smooth will be entirely free from radiating striæ, and the edges of the mantle of those animals are probably quite plain.

The shells in the living state are covered with an epidermis, remains of which may be occasionally observed upon specimens of the Eocene deposits. Some have their radiations strongly decussated by elevated lines of growth; a few species also have a peculiar ornament in a zigzag form, and for these a sub-genus has been proposed, under the name *Acila*,

by Messrs. Adams. I have not seen this kind of sculpture upon any Eocene fossils. In this genus it is often difficult to determine, in descriptions, which part is intended for the "anterior," as that term is applied sometimes to the shorter, at others to the longer division of the shell.

It has been generally supposed that the species of *Nucula* are well defined and easily determined, but I am sorry to say, they have not appeared so to me. The Eocene species have given me more trouble in their assignment than those of almost any other genus, and the result is not at all satisfactory to myself; it will be fortunate for me if I be the only one of that opinion. The Eocene shells of this genus found in England, and here illustrated, present a great variety of forms, most of which I have considered as entitled to specific distinction; it is however possible, that with a larger amount of materials, some of these lines of division might disappear.

1. *NUCULA AMPLA*, Edwards, MS. Tab. XVIII, fig. 5, *a*, *b*, var. fig. 6, *a*, *b*.

Spec. Char. *N. testá transversá, ovato-subtrigonulá vel nuciformi, amplá, tumidiusculá, crassá, lævigatá; pedi-regione latiore; ano-regione paulo attenuatá, rotundatá; margine dorsali convexiusculá; margine ventrali plús convexá; lunulá elongato-lanceolatá; dentibus ad apicem gradatim minutis; marginibus crenulatis.*

Shell transverse, ovately trigonular or nut-shaped, broad, somewhat tumid, thick, smooth; pedal region the broader; anal region slightly projecting and rounded; dorsal margin slightly convex, ventral margin more rounded; lunule elongated; denticles diminishing towards the apex; margins crenulated.

Length, $\frac{1}{2}$ an inch.

Locality. Barton (Edwards).

This species, I believe, is not very rare. Its peculiar or specific distinction is the roundedly ovate form, which appears to be more so than in any other species I have seen. The anal region is much rounded, and the dental area on that side short, by which is given a greater convexity to the ventral margin. It has an elongated indistinct lunule or dorsal depression, with a slightly elevated corselet surrounded by a depression; it bears some resemblance to *N. lunulata*, Nyst, but it appears to differ from that species in having both dorsal and ventral margins more curved, and it has not so distinct and prominent a corselet as that species. The interior is sometimes much thickened, and the adductor marks are deep; there is also an elongated impression of the pedal muscle near the oral adductor, beneath the dental margin, and generally in thickened specimens an upright visceral (?) impression. Fig. 6, *a*, *b*, in same plate, represents a specimen in Mr. Edwards's cabinet with the MS. name of *contigua*; in this there is a slight difference in the contour, and in the anal region, but I think it is scarcely entitled to specific distinction. I have therefore considered it only as a variety of the above species.

2. *NUCULA BISULCATA*, *J. Sowerby*. Tab. XVIII, fig. 13, *a—c*.

NUCULA BISULCATA. *J. Sow.*, in *Dixon's Geol. of Sussex*, pp. 93, 170, t. 2. fig. 13. 1850.

— — — *Morris*. *Catal. Brit. Foss.*, p. 217, 1854.

Spec. Char. *N. testá ovato-subtrigoná, elongatá, crassá, lævigatá; pedi-regione ellipticá, longiore et altiore; siphoni-regione angulatá, subproductá, compressiusculá; lunulá elongato-lanceolatá, bisulcatá; ano ovato, in medio prominente; dentibus ad apicem gradatim minutissimis; marginibus integris.*

Shell ovately sub-trigonal, elongated, thick, compressed, smooth; pedal region elliptical, margin ovately rounded; siphoni-lateral margin angulated, compressed, and slightly produced; lunule elongately lanceolate, with a central ridge; anal region ovate, prominent in the centre; teeth diminishing towards the umbo, ventral margin smooth.

Length, $1\frac{1}{2}$ inch; *height*, 1 inch.

Localities. Barton, Bracklesham.

Specimens of this species are not very abundant, and have, I believe, been as yet only found at the above localities.

The shell is nearly smooth, with the exception of distinct lines of growth. The dorsal margin has a sort of flattened space (lunule), with a central elevation or ridge, on each side of which is a depression or furrow, giving a sinuation to the pedi-lateral margin, and to this peculiarity of character the species owes its name. The muscle-marks are both deeply impressed, the anal one more especially so; it is of an elongated form, pointed towards the umbo, and there is also an impression in the umbonal region, probably left by the retractors of the foot. The teeth are not numerous, about a dozen on the pedal side, and half that number on the other. The shell in the living state was probably covered with a thick epidermis; traces of this may be seen on many specimens. The nearest approach to this is a recent species, *N. Cumingii*, from the Indian Archipelago, but from which it differs, according to description, in not having the lunule with a bipartite division.

3. *NUCULA BOWERBANKII*, *J. Sowerby*. Tab. XVIII, fig. *f*, 14, *a, b*.

NUCULA BOWERBANKII. *J. Sow.* *Geol. Trans.*, 2nd series, vol. v, t. 8, fig. 11, 1834.

— — — *Prestwich*. *Geol. Journ.*, 1847, p. 405.

— — — *Morris*. *Cat. Brit. Foss.*, p. 217, 1854.

Spec. Char. *N. testá latè ovatá, subtrigoná, valdè inæquilaterali, convexá, radiatim striatá; striis depressis, latis, approximatis; siphoni-regione obliquè truncatá; lunulá elongato-lanceolatá vix perspicuá; marginibus crenulatis.*

“Elliptical, convex, smooth externally, striated within; anterior (?) extremity obliquely

truncated ; the slope filled by a large, pointed, nearly flat lunette, edge toothed ; impression of the abductor muscles shallow."—(*J. Sowerby*).

Length, 1 inch ; *height*, $\frac{3}{4}$ ths of an inch.

Localities. Highgate, Potter's Bar (*Wetherell*) ; Haverstock Hill (*Edwards*).

This species was apparently covered by a thick epidermis, and the umbones have been very much eroded. The anal region or corselet is well marked and flat, with a slight rise in the centre, and covered only by lines of growth. The surface of the shell is smooth to the unassisted eye, but it is covered with narrow, deep, radiating lines, making the rays broad and flat, and there is a depression on the dorsal portion of the pedal region irrespective of the lanceolated lunule, as if the ventral margins were capable of being widely separated. The species appears to be confined to the London Basin.

The interior cast of a shell of this genus is figured and described in the 'Trans. of the Geol. Soc.,' 2nd series, vol. v, pl. 24, fig. 5, under the name *N. Baboensis*, and is said by the author to "nearly resemble *N. Bowerbankii*, but not truncated or pointed below the lunette." This specimen came from Baboo Hill in Cutch, and it is in that easterly direction that we might look, I think, for shells probably identical with some of our own Eocene fossils, but I fear it is not possible to certify a species by the cast alone. There is also the cast of a species in this genus found in the Eocene Formation, between Holyport and Birfield ; the specimen was deposited in the Museum of the Geological Society, by the late Mr. Warburton (marked No. 17839), and has a somewhat similar form, but it presents the same difficulty for determination, and I am unable to assign it to any species ; these various casts do not show whether the inner margins were furnished with crenulations.

4. *NUCULA CARDIOIDES*, *Edwards*, MS. Tab. XIX, fig. 8.

A single specimen from Pegwell Bay, in the cabinet of Mr. Edwards, has the above name attached to it, and it appears to belong to a distinct species ; but it is very imperfectly preserved, and I am unable to describe its true characters. The shell is externally rayed with distinct and well-marked striæ or riblets, and the inner margin is crenulated. Its present name must be considered provisional.

5. *NUCULA COMPRESSA*, *J. Sowerby*. Tab. XIX, fig. 5.

NUCULA COMPRESSA. *J. Sow.* Geol. Trans., vol. v, 2nd ser., p. 136, pl. 8, fig. 14, 1834.

— — *Prestwich*. Geol. Journ., 1847, p. 405.

— — *Morris*. Catal. Brit. Foss., p. 217, 1854.

Spec. Char. *N. testá, elongato-ovatá, turgidá, tumidá, inæquilaterali; lævigatá, glabrá, margine dorsali subrectá, pedi-regione ovatá; siphoni-regione, prælongá, subrostratá; margine ventrali convexá; lunulá vix conspicuá; apicibus depressis; marginibus integris.*

Shell elongately ovate, inflated, inequilateral, smooth and glossy; dorsal margin nearly straight; ventral margin convex; pedal region large, ovate; siphonal region obtusely pointed; lunule inconspicuous; beaks depressed; margins smooth.

Length, $\frac{9}{16}$ ths of an inch; *height*, $\frac{5}{16}$ ths of an inch.

Locality. Hampstead Heath (*Wetherell*); Potter's Bar, and Highgate (*Edwards*).

The peculiar distinction is the pointed or subrostrated form of the siphonal region, where it is slightly compressed, from which I presume it received its name, as the shell is otherwise rather tumid.

6. NUCULA CONSORS, *S. Wood*. Tab. XIX, fig. 7, *a, b*.

NUCULA SIMILIS. *J. Sow.* Min. Conch., vol. ii, p. 207, t. 192, figs. 3, 4, 1819.

Spec. Char. *N. testá obovatá, transversá, subtrigonulá, turgidá, valdè inæquilaterali, obsoletè radiatá, aliquantisper striis transversis decussatá; pedi-regione prolongá, obtusá; siphoni-regione rotundatè truncatá; margine ventrali convexá; lunulá vix distinctá; ano ovato in medio prominenti; marginibus crenulatis.*

Shell transverse, obtusely ovate, roundedly trigonal, turgid, very inequilateral, obsoletely rayed, slightly decussated by lines of growth; pedilateral margin obtusely or roundedly angulated; dorsal and ventral margins convex; lunule indistinct; anal region slightly prominent; internal margins crenulated.

Length, $\frac{1}{2}$ an inch; *height*, $\frac{3}{8}$ ths of an inch.

Locality. Highgate (*Wetherell*).

Many specimens of this species are in the cabinet of Mr. Wetherell; but they are seldom in good condition, the greater number of them being merely casts.

Professor Morris, in his 'Catalogue of British Fossils,' has rejected figs. 3 and 4, t. 192, 'Min. Conch.,' from being identical with the Barton species figured upon the same plate, and Mr. Sowerby says, at p. 208, he is doubtful whether fig. 4 ought not to be considered a distinct species, or at least a distinct variety, implying thereby a doubt as to the propriety of admitting it under the name of *similis*. I have, therefore, given it a new specific name with more confidence, having the support of the above two opinions. It resembles in many of its characters one or two species from the Middle Eocene, but with none does it appear to be truly identical. It has no distinctly marked lunule. There is a prominent anal region surrounded by a depression, and in those specimens which are best preserved the radiating striæ are very distinct, decussated by lines of growth. The two valves are most commonly united, and many of them have been perforated by a zoophagous feeder.

Fig. 3 in 'Min. Conch.' is more angulated than fig. 4, but I think they both belong to the same species, as there is considerable variation in the outline among Mr. Wetherell's specimens.

7. *N. CURVATA*, *Edwards*, MS. Tab. XVIII, fig. 12, *a*, *b*.

Spec. Char. *N. testá transversá, ovato-subtrigonulá, tumidiusculá, crassiusculá, obsoletè radiatá, radiis vel striis tenuissimis; valdè inæquilaterali; pedi-regione angulatá, productá; ano-regione brevi, in medio prominenti; margine dorsali sub-rectá; margine ventrali convexiusculá; lunulá lanceolatá vix conspicuá; marginibus crenulatis.*

Shell transverse, ovately trigonular, slightly tumid, and moderately thick; obsoletely radiated with very fine lines or striæ; pedal region produced and angulated; anal region short, and rather prominent in the centre; dorsal margin nearly straight, ventral margin curved; lunule scarcely conspicuous, margins crenulated.

Length, $\frac{3}{8}$ ths of an inch.

Locality. Clarendon (*Edwards*).

This species is at present very rare. It somewhat resembles *N. sphenoides*, but it is comparatively longer; it is more produced and angular at the pedilateral margin, and it is less tumid than the Upper Eocene shell.

Two or three specimens in Mr. Prestwich's cabinet, obtained from a boring for an Artesian well at Southampton, appear to belong to this species; the age of the bed from which they came is not stated.

8. *NUCULA DIXONI*, *Edwards*, MS. Tab. XVIII, fig. 7, *a—c*.

NUCULA SIMILIS. *J. Sow.*, in *Dixon's Geol. of Suss.*, p. 93, t. 2, fig. 7, 1850.

Spec. Char. *N. testá ovato-subtrigonulá, turgidá, lævigatá, valdè inæquilaterali, convexá; siphoni-regione truncatá; lunulá obtusè angulatá vix perspicuá; cardine crassá, dentibus magnis; fossulá connexús elongatá; marginibus crenulatis.*

Shell ovately triangular, somewhat tumid, smooth, convex, very inequilateral; siphonal region truncated; lunule and corselet not very distinctly defined; teeth thick and broad towards the connector, margins crenulated.

Length, $\frac{7}{8}$ ths of an inch; *height*, $\frac{11}{16}$ ths of an inch.

Localities. Bracklesham, Stubbington, Whitecliff Bay (*Edwards*).

This species is by no means rare at Bracklesham. It appears to differ from *similis* in being more tumid and less angular, and rather more elongated, and it has not the projecting pointedness at the basal margin of the siphonal region which is characteristic of that species. The exterior is more convex, and the radiating lines are less distinct in this than they are

in *similis*, which is its nearest relative. It bears a strong resemblance to *N. margaritacea* of Nyst, 'Coq. Foss. Belg.,' p. 229, pl. xvii, fig. 9, *a, b*, but the dorsal margin of that figure is rather more curved. *N. margaritacea*, Goldf., 'Petr. Germ.,' vol. i, p. 158. t. 125, fig. 21, *a—d*, also much resembles it.

Some specimens in Mr. Edwards's cabinet from the same locality have attached to them the MS. names of *quadrans*, Tab. XVIII, fig. 8, *a, b*, and *planiuscula*, same plate, fig. 9; they differ in outward form, as those names indicate, but I think they are varieties of the above. It is possible they may prove to be distinct.

9. *NUCULA HEADONENSIS*, Forbes, MS. Tab. XVIII, fig. 3, *a, b*.

NUCULA HEADONENSIS. Morris. Mem. Geol. Surv., p. 156, pl. 6, figs. 12, 12, *a, b*, 1856.

— — — Id. Catal. Brit. Foss., p. 218, 1854.

Spec. Char. "*Testá ovato-transversá, depressá, lævi, latere antico brevi, subproducto, margine arcuato, posticè angusto, margine ventrali subarcuato, intus crenulato; lunulá prominulá, sulco perspicuo circumdatá.*"

"An ovately transverse and somewhat depressed shell, with the anterior margin short and slightly produced, the posterior extremity narrowed, the ventral margin arched and internally very finely crenulated; the lunule prominent, and surrounded by a conspicuous furrow."—*Morris*.

Length, $\frac{3}{8}$ ths of an inch.

Localities. Colwell Bay, Headon Hill (*Morris* and *Edwards*), Hordwell (*S. Wood*).

This species has been separated from *similis* by the late Edward Forbes; it has also been considered by Mr. Morris as distinct, and I readily acquiesce in the separation. Specimens are not particularly rare, and are found often in a very perfect state of preservation. It somewhat resembles in outline *N. Dixoni*, but it is a smaller species; the siphonal region is shorter, and the basal extremity on that side is more rounded, and it appears also to be a thicker shell. In the 'Catal. Brit. Foss.,' p. 218, 1854, *Nucula similis*, Wood, is given as a synonym to this species, but I have not been able to find the reference.

10. *NUCULA LISSA*, Edwards, MS. Tab. XVIII, fig. 4, *a, b*.

Spec. Char. *N. testá elongato-ovatá, tenui, lævi, glabrá, compressiusculá, inæquilaterali; pedi-regione latiore, ovatá; siphoni-regione obliquè truncatá, subrostrata; marginibus dorsali et ventrali convexis; lunulá lanceolato-elongatá, depressá; ano cordiformi; dentibus ad apicem gradatim minutissimis; marginibus integris.*

Shell elongately ovate, thin, smooth, and glossy, slightly compressed, inequilateral; pedal-region the wider and ovately rounded; siphonal region obliquely truncated; dorsal

and ventral margins curved; lunule elongate, distinct, and rather depressed; anal region heartshaped; teeth small near the beak; margins smooth.

Length, $\frac{1}{2}$ an inch; *height*, $\frac{5}{16}$ ths of an inch.

Localities. Highcliff, Barton, Brockenhurst, Hordwell (*Edwards*).

Although a thin and delicate shell, it has been obtained by Mr. Edwards in great abundance. The exterior is smooth and glossy, with a few concentric ridges or obtuse lines of growth. The interior has a strong nacreous lustre, with an enamelled exterior. The hinge-line is narrow; it has about a dozen denticles on the pedal side, with scarcely half that number on the other, and the support for cartilage is simple, somewhat elongated, projecting inwardly at an angle of 45° to the dorsal margin. There is a deep depression (lunule?) on the pedal region, producing a sharp elevation to the dorsal margin, with a faint depression on the siphonal or anal region, but not very well defined. The extremity of the siphoni-lateral margin is rather short and generally more or less pointed or subrostrated; this gives a considerable convexity to the ventral margin in the normal form. The shell is thin, and the oral muscle scarcely visible, but the anal one is large and well impressed.

There are, I think, three varieties of this species; at least, there are three different forms, which I have referred to the above name, presenting as they do considerable difference in outline, but not, I think, sufficient to entitle them to different specific positions. Tab. XX, fig. 1, *a*, *b*, *c*.

11. NUCULA MINOR, *Deshayes*. Tab. XVIII, fig. 10.

NUCULA MINOR. *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 823, pl. 64, figs. 17—20, 1860.

Spec. Char. *N.* “*testá minimá, ovato-trigoná, turgidula, valdè inæquilaterali; posticè transversim truncatá; supernè declivi; anticè attenuatá, transversim tenui-sulcatá; sulcis anticè paulo undulatis; lunulá nullá; ano plano, non circumscripto; cardine angusto, pauci dentato; dentibus angustis distantibus; fossulá minimá, brevi, angustá; marginibus sub lente minutissime crenulatis.*”—*Desh.*

Shell small, ovately trigonular, slightly tumid, siphonal region short, obliquely truncated; pedal region ovately rounded; concentrically ridged or sulcated; ridges slightly irregular; no lunule; anal region smooth, convex in the centre; dental margin narrow, teeth few and small; margins crenulated.

Length, $\frac{1}{8}$ th of an inch.

Localities. Bracklesham (*Edwards*).

France. Le Guépelle, Chéry-Chartreuve, Ver, Beauval, Houdan (*Deshayes*).

The figure was taken from a unique and perfect specimen in the cabinet of Mr. Edwards.

So far as I am able to determine from figure and description in the work above referred to, I think our little shell may be considered as identical with the Paris Basin

species. The only difference I can perceive between the English and the French fossils is in the contour of the specimens; ours being apparently a little longer and rather more rounded on the pedilateral margin. Our shell is ridged concentrically, and these ridges are rather broad, and occasionally inosculate or undulate, like those spoken of by M. Deshayes, "quelquefois un peu onduleux vers l'extrémité antérieure."

A recent species from the Straits of Malacca, figured and described by Mr. Hanley under the name of *N. marmorea* ('Monog. of Nuculidæ,' p. 48, pl. v, fig. 145), appears, from representation, to be its nearest relative.

12. *NUCULA NUDATA*, *S. Wood*. Tab. XX, fig. 4, *a*, *b*.

Spec. Char. *N. testá ovato-trigoná, transversá, tenui, valdè inæquilaterali, lævigatá; margine dorsali vix incurvatá, margine ventrali convexiusculá; pedi-regione ovato-rotundatá; lunulá inconspicuá; ano depresso, ovato; marginibus integris.*

Shell ovately trigonal, transverse, thin, smooth, very inequilateral; dorsal margin nearly straight, ventral margin slightly curved; pedal side roundedly ovate; lunule inconspicuous; anal region depressed; margins smooth.

Length, $\frac{1}{3}$ rd of an inch.

Locality. Headon Hill (*S. Wood*). Brockenhurst? (*Edwards*).

A few specimens of this species were found by myself many years ago, and I have considered them as entitled to the rank of a distinct species, in consequence of the ventral margins being quite free from denticulations, and of the outward form differing from that of any other smooth-margined species.

The shell in its contour much resembles *N. Headonensis*, but it is a little longer, more rounded, and less tumid than in that species, and it is distinguished by the difference of margin. It bears, also, some resemblance to *N. lissa*, but it differs in two or three characters; in the latter species the anal or siphonal side is more pointed or acutely angular, the dental area shorter, and the ventral margin more rounded than in *N. nudata*; in *N. lissa*, there is also a more distinct sinus or lunule below the dorsal edge on the pedal side, and the shell is comparatively longer and thinner. The angle formed by the two dental lines in this species is very little more than a right angle, but in *N. lissa* that angle is very obtuse.

13. *NUCULA PRÆLONGA*, *Edwards*, MS. Tab. XIX, fig. 4 *a*, *b*.

Spec. Char. *N. testá elongato-ovatá, prælongá, lævigatá, tenui, convexiusculá, inæquilaterali; pedi-regione ovato-rotundatá; siphoni-regione obliquè truncatá; lunulá elongato-*

lanceolatá, bisulcatá; ano ovato, obtusè circumdato, in medio prominenti; apicibus depressis, approximatis; marginibus integris.

Shell elongately ovate, smooth, thin, and slightly convex or tumid, inequilateral; pedal region ovately rounded; siphonal region obliquely truncated, or very obtusely rostrated; lunule elongated with a central elevation or ridge; anal region ovate and centrally elevated; beaks depressed; margins smooth.

Length, 1 inch; *height*, $\frac{1}{2}$ an inch.

Localities. Barton (*Edwards*).

This species has considerable affinity with *N. bisulcata*. It appears to differ in being of a more elongated form, and in having the siphonal region more inflated; the whole shell appears to be more regularly convex, and the concentric lines or lines of growth are more distinct than they are upon *N. bisulcata*.

This shell, perhaps, was not covered with a very thick epidermis, as there are no remains of it upon any of the specimens I have seen, and the beaks are not eroded.

14. *NUCULA PRÆLONGATA*, *S. Wood*. Tab. XIX, fig. 1 *a, b*.

Spec. Char. *N. testá ovato-elongatá, prælongatá, tenui, lævigatá, convexiusculá, inæquilaterali; pedi-regione ovato-rotundatá; siphoni-regione brevi, subangulatá; lunulá lanceolatá, bisulcatá; ano ovato, circumdato, in medio prominenti; apicibus depressis, approximatis; marginibus crenulatis.*

Shell ovately elongate, thin, smooth, and slightly tumid, inequilateral; pedal region roundedly ovate; siphonal side short and slightly angulated; lunule elongate, with double shallow depression; corselet slightly prominent in the middle; beaks depressed; margins crenulated.

Longest diameter, 1 inch nearly.

Locality. Bracklesham (*Edwards*).

Only two or three specimens of this species have come under my observation; they somewhat resemble in form *N. prælonga*, but the crenulated margin will distinguish them, and there is a difference, also, in their comparative lengths. This shell seems, also, to be more iridescent than *N. prælonga*, and rather more deep or tumid.

Two other specimens from the same locality, in Mr. Edwards's cabinet, have a somewhat similar outline, but they have not the basal portion of the anal region quite so much extended or angular; they appear, also, to have a more distinct lunule and corselet than the one figured (*prælongata*); and these depressions (lunule and corselet) are divided by a small central ridge, which I do not perceive in our figured specimens. I am, however, unwilling to separate them, as they otherwise correspond, and future observations must determine whether they be the same or different.

15. *NUCULA PROAVA*, *S. Wood*. Tab. XX, fig. 3, *a*, *b*.

Spec. Char. *N. testá transversá, ovato-oblongá, turgidulá, lævigatá, valdè inæquilaterali; umbonibus minimis, terminalibus; lunulá nullá; ano brevì, ovato, in medio prominulo; margine dorsali convexiusculá; margine ventrali curvatá; dentibus ad apicem gradatim minutissimis; marginibus integris.*

Shell transverse, ovately oblong, slightly tumid, smooth, and very inequilateral; beaks small, depressed, terminal; no lunule; anal region short, distinct, and slightly prominent in the centre; dorsal and ventral margins slightly curved, the latter rather the more so; teeth not very close, diminishing towards the umbo; margins smooth.

Length, $\frac{3}{4}$ ths of an inch; *height*, $\frac{1}{2}$ an inch.

Locality. Near Bishopstone, Herne Bay.

A single specimen of this species is in the Museum in Jermyn Street, and the officers of that establishment have kindly permitted me to have it figured. It is the only one that I have seen.

The nearest approach to this shell that I know is *N. lævigata* of the Coralline Crag, but it differs from that species in outline; it is less curved in the ventral margin, and the anal region is shorter. In form it somewhat resembles *N. Bowerbankii*, but that species has the inner margins crenulated. The denticles are not very numerous on the pedal side; they are hidden by the matrix on the margin of the anal region; so, also, is the place for connexus.

16. *NUCULA PROTRACTA*, *Edwards*, MS. Tab. XVIII, fig. 15.

Spec. Char. *N. testá transversá, elongato-ovatá, lævigatá, tenui, tumidiusculá, valdè inæquilaterali; pedi-regione ovato-subattenuatá; siphoni-regioni brevì, obliquè truncatá vel angulatá; lunulá parvâ, lanceolatâ, unisulcatâ; ano ovato, vix conspicuo; marginibus crenulatis.*

Shell transverse, elongately oval, smooth, thin, slightly tumid, and very inequilateral; pedal region obtusely pointed; siphonal region short, obliquely truncated or angulated; lunule small, plain, elongated, and flat; corselet ill-defined; margins crenulated.

Length, $\frac{7}{8}$ ths of an inch; *height*, $\frac{9}{16}$ ths of an inch.

Locality. Bracklesham (*Edwards*).

A single specimen in Mr. Edwards's cabinet, from which the figure above referred to was taken, appears to be distinct, and I have, in consequence, adopted the MS. name

attached to it. The nearest approach to this in outward form is *N. sericea*, Tab. XIX, fig. 3, but that is a smaller shell, with the dorsal margin less convex and the ventral margin less curved than in this species; this shell is more ovate or less wedge-shaped, with the terminal portion of the siphoni-lateral margin more pointed, and the siphonal region slightly compressed. It resembles in outline *N. bisulcata*, but that shell has a smooth margin.

17. *NUCULA SIMILIS*, *J. Sowerby*. Tab. XVIII, fig. 11 *a—c*.

NUCULA SIMILIS. *J. Sow.* Min. Conch., t. 192, fig. 10, 1819.

— — *Morris.* Catal. Brit. Foss., p. 218, 1854.

— *TRIGONA.* *J. Sow.* Min. Conch., t. 192, fig. 5, 1819.

ARCA NUCLEUS. *Solander*, in Brand. Foss. Hanton., p. 40, t. 8, fig. 101, 1766.

Spec. Char. *N. testá ovato-trigóná, crassá, sub-compressá, lævigatá aut obsoletè radiatá, concentricè irregulariter lineatá; siphoni-regione brevissimá, truncatá, ad basim eversá, sub-acuminatá; lunulá anoque angulo obtuso; dentibus numerosis; marginibus crenulatis.*

Shell ovately trigonal, thick, slightly compressed, smooth, or indistinctly radiated, and irregularly furrowed concentrically; siphonal region short, truncate, with the basal termination everted and somewhat pointed; lunule and corselet indistinctly defined; denticles numerous, rather thin and compressed; margin crenulated.

Length, 1 inch; *height*, $\frac{3}{4}$ ths of an inch.

Locality. Barton.

Considerable difficulty exists with regard to this species, of which numerous specimens are found at Barton. It is, I believe, the true *Arca nucleus* of Solander, a specimen from his collection being still in the British Museum. *N. trigona*, Sowerby, is probably only the young, or, at most, a variety of this species; and as it is so marked upon Mr. Edwards's tablet, I am pleased to find he is of the same opinion. There is a French shell figured by M. Deshayes, *N. mixta*, 'An. sans vert. du Bassin de Par.,' t. 1, p. 819, pl. 64, figs. 1—4, which very closely resembles it; but he says the distinctions between the specimens themselves are evident and permanent, and such as will justify specific separation. Our shell is a handsome one, and is of considerable solidity, rather flat or compressed; it is readily distinguished from all other species excepting *N. mixta*. The distinguishing character is an extension or pointedness at the extreme basal portion of the siphonal region, and the hinge also is somewhat peculiar, often presenting broad teeth near the umbo.

18. *NUCULA SPHENOIDES*, *Edwards*, MS. Tab. XVIII, fig. 2, and Tab. XIX, fig. 2 *a, b*.

Spec. Char. *N. testá minutá, irregulatim trigoná vel sphenoidéá, tumidá, lævissimá, politá; pedi-regione ovato-angulatá; siphoni-regione brevissimá, truncatá; ano distincto, circumdato, in medio prominenti; lunulá elongatá, depressá, divisá; margine dorsali sub-arcuatá; margine ventrali convexá; marginibus crenulatis.*

Shell small, roundedly triangular or wedge-shaped, tumid, smooth, and glossy; pedal region obtusely pointed; siphonal region very short, with a prominent anal corselet surrounded by a depression; ventral margin very convex, with the edges crenulated.

Length, $\frac{5}{16}$ ths of an inch.

Localities. Hempstead, Brook? (*Edwards*).

A few specimens of an elegant little species enrich the cabinet of Mr. Edwards, and there is attached to them the above name in MS. They very closely resemble a species in the Paris Basin figured and described by M. Deshayes under the name of *N. Greppini*, especially the specimen represented by fig. 2, Tab. XIX, and when the specimens themselves are compared they may possibly prove to belong to the same species, but I have not the means of doing this. There is, however, an apparent difference, which I may here point out. Our shell has the dorsal margin less curved, while the ventral margin is more so, than is represented in the figure of *N. Greppini*, Desh., p. 882, pl. lxiv, figs. 13—16; and it has a distinct lunule or dorsal depression, divided by a slight central ridge, and it is more tumid. The anal region also has apparently a more prominent centre and deeper external depression.

19. *NUCULA SERICEA*, *S. Wood*. Tab. XIX, fig. 3.

Spec. Char. *N. testá tenui, transversá, subtrigonulá, lævigatá, glabrá, calvatá aut obsoletè radiatá; pedi-regione productá, angulatá; siphoni-regione obliquè truncatá, sub-attenuatá; lunulá inconspicuá; margine dorsali convexiusculá; margine ventrali arcuatá; umbonibus acutis, terminalibus; marginibus crenulatis.*

Shell thin, transverse, subtrigonular, smooth, glossy, naked, or with obsolete radiating striæ; pedal region produced and angulated; siphonal side obliquely truncated, and somewhat pointed; lunule inconspicuous; dorsal margin slightly convex, ventral margin more curved; beaks terminal; inner margins crenulated.

Length, $\frac{1}{3}$ an inch.

Localities. White Cliff, Hunting Bridge (*Edwards*).

This species somewhat resembles *prælongata* and *protracta*, but it protrudes more on the siphonal side, and the ventral margin is more rounded. It differs also in the anal

region, and it is comparatively shorter. The shell is thin, and there is no perceptible or distinct lunule on the pedal region; neither is there any distinct corselet. The specimens, which are few in number, adhere firmly to the matrix, and I am unable to see the interior.

20. *NUCULA SUBTRANSVERSA*, *Nyst.*? Tab. XIX, fig. 13.

NUCULA SUBTRANSVERSA. *Nyst.*? Coq. Foss. Belg., p. 227, pl. xviii, fig. 7, *a, b*, 1844.

— *OVATA.* *Id.*? Rech. Coq. Foss. de Hoesselt et Kl. Sp., p. 13, No. 31, 1836.

— — *Potiers et Mich.*? Catal. de Moll. de Douai, t. ii, p. 120, No. 3, 1844.

Spec. Char. *N. testá transversá, oblongo-ovatá, turgidá, valdè inæquilaterali, obsolete radiatá; pedi-regione prælongá, paulo attenuatá; margine dorsali subrectá; margine ventrali convexiusculá; lunulá inconspicuá; ano ovato, in medio prominenti; marginibus crenulatis.*

Shell transverse or elongate, ovately oblong, or obtusely wedge-shaped; very inequilateral; obsolete radiated; pedilateral margin slightly pointed; dorsal margin nearly straight; ventral margin gently curved; corselet or anal region ovate, elevated in the middle; margins crenulated.

Length, $\frac{11}{16}$ ths of an inch; *height*, $\frac{7}{16}$ ths of an inch.

Locality. White Cliff Bay (*Fisher*).

The specimen figured enriches the cabinet of Mr. Fisher, who tells me it is not rare, but very difficult to obtain in any degree of perfection.

I have considered it as identical with the Belgian species, depending entirely for so doing upon figure and description, although the proportions given by M. Nyst do not quite accord with those of our own shell. This is extremely transverse or elongate—more so than any other species from the English Eocene deposits; and the umbo, which is depressed and much eroded, is at the extremity of the shell, the siphoni-lateral margin forming almost a right angle with the dorsal edge. The outer surface shows distinct but irregular lines of increase, and the nearly obsolete rays upon the specimen are most visible towards the pedilateral margin, as they are described to exist on the Belgian shell.

M. Nyst points out a distinction which exists between his shell and the one which he considers to be the same from the Paris Basin in the number of the hinge-teeth. Unfortunately I am unable to ascertain the dental characters of our shell.

21. *NUCULA THANATIANA*, *Edwards*, MS. Tab. XIX, fig. 6.

Spec. Char. *N. testá ovato-trigoná, convexiusculá, tenui, valdè inæquilaterali, radiatim striatá; striis tenuibus, sub-decussatis; lunulá nullá aut indistinctá; ano plano, lævigato; cardine crassiusculo, umbonibus minimis; marginibus dorsali et ventrali convexiusculis; margine ventrali crenulatá.*

Shell ovately triangular, rather convex or tumid, thin, very inequilateral, and covered with radiating striæ; striæ fine and irregularly decussated; no distinct lunule; siphonal or anal region flattish and smooth; hinge rather thick, umbones small; dorsal and ventral margins slightly and nearly equally convex; margins crenulated.

Length, $\frac{1}{2}$ an inch.

Locality. Pegwell Bay (*Edwards*).

The figure above referred to was taken from an unique specimen in Mr. Edwards's cabinet, of which the umbo was not quite perfect; it represents the shell as rather more elongated than it ought to be.

22. *NUCULA TUMESCENS*, *Edwards*, MS. Tab. XVIII, fig. 1 *a—c*.

Spec. Char. *N. testá ovato-trigonulá, tumescenti, crassiusculá, lævigatá, obsolete radiatá; pedi-regione sub-cuneatá; siphoni-regione brevissimá, truncatá; umbonibus terminalibus, depressis; lunulá indistinctá; marginibus crenulatis; dentibus numerosis, ad apicem decrescentibus.*

Shell ovately triangular and wedge-shaped, tumid, rather thick, and smooth; pedal region obtusely wedge-shaped; siphonal region very short; exterior obsoletely rayed; beaks terminal, depressed; lunule indistinct; anal region marked with an obtuse elevation or ridge; margins crenulated; teeth numerous, decreasing towards the umbo.

Length, $\frac{1}{2}$ an inch; *height*, $\frac{5}{16}$ ths of an inch.

Localities. Mead End, Barton (*Edwards*).

This is not rare. The principal distinction of the species is its great tumidity, thereby giving more than ordinary depth to the interior of the umbonal region.

23. *NUCULA WETHERELLII*, *J. Sowerby*. Tab. XIX, fig. 9 *a, b*.

NUCULA WETHERELLII. *J. Sow.* Geol. Trans., 2nd ser., vol. v, pl. viii, fig. 12, 1834.

— — *Prestwich.* Geol. Journ., 1847, p. 405.

— — *Morris.* Catal. Brit. Foss., p. 218, 1854.

Spec. Char. *N. testá ovatá, vix elongatá, gibbosá, lævigatá, subinæquilaterali; pedi-regione rotundatá; siphoni-regione obliquè truncatá vel obtusè rostratá; umbonibus depressis; marginibus crenulatis.*

"Shell suborbicular, transverse, gibbose, smooth; extremities pointed; beaks nearly central, margin obtuse, edge toothed."—*J. Sowerby.*

Length, $\frac{1}{2}$ an inch.

Locality. Hampstead Heath (*Wetherell*); Highgate, Sheppy? (*Edwards*).

"The radiating structure of this *Nucula*, common to the species of the genus, is very conspicuous, but the inner surface is not striated, as in *N. Bowerbankii*."—*J. Sowerby.*

The specimens of this species that I have seen are not numerous, and, unfortunately, they are not in perfect condition; the umbones are excessively eroded, thereby reducing their natural proportions, giving a slightly rounded outline to the shell.

Since the type for the preceding descriptions has been set up, several specimens belonging to this genus have come under my inspection, which I cannot assign to any of the foregoing species; and although they do not present characters sufficiently determinable for specific isolation and description, they are, I conceive, fully deserving of representation and notice, and I propose here to give to them provisional names only until they can hereafter, by the possession of more specimens, be satisfactorily characterised.

Tab. XX, fig. 10, represents the interior cast of a shell from Clewer Green, near Basingstoke, kindly lent to me by Mr. Prestwich, and to which I will give the name of *N. venusta*; it appears to have possessed a smooth margin to the edge of the valves, and it has a very slight basal projection on the siphonal side; there is a prominence in the anal region, and in its contour it is intermediate between *N. bisulcata* and *N. prælonga*, but to neither of those smooth-margined species can it, I think, be referred. The age of the deposit in which it is found being greater than that of the two other species strengthens the supposition that this is distinct.

Tab. XX, fig. 7, is the representation of a specimen, also from Mr. Prestwich's cabinet, to which the locality Cuffells is attached; this appears to be different from any of the foregoing, but it is imbedded in the matrix, and I am unable to describe its true characters. I give it the name of *N. consobrina*; in outline it somewhat resembles *N. consors*, from Highgate, but is, I think, too long and too much truncated for that species; it has a very slight elevation in the anal region, but there is no perceptible lunule, although there is a slight depression on the dorsal surface extending from the umbo to the verge of the pedal extremity; the shell is thick, nacreous within, and the denticles are large, twenty-four on the pedal side, and seven or eight on the other.

Tab. XX, fig. 6, represents a specimen very recently obtained from the Woolwich series at Bickley, by Chas. A. Meyer, Esq.; this shell has been kindly submitted to my examination. It is probably distinct, and I will call it for the present *N. gracilentia*; its nearest relative appears to be *N. fragilis*, but on a comparison with specimens of that

species in the British Museum, it presents the following differences:—*N. fragilis* has the basal margin on the anal side more pointed, with the centre of the anal region more elevated and distinct, and the pedilateral margin is not quite so much rounded: there appears also to be a difference in the number of denticles, but a larger number of specimens will be required to determine its correct position.

Tab. XX, fig. 9, is a shell recently obtained by Mr. Gibbs from the Basement-bed of the London Clay at Herne Bay, and the officers of the Museum in Jermyn Street, to which it belongs, have kindly permitted me to have it figured. I am unable to refer it to any known species, and propose to give to it the name of *N. striatella*. It appears to be specially distinguished by an unusually prominent anal region; it is finely rayed, and the margins are denticulated.

Tab. XX, fig. 8 *a*, represents a specimen also from the Thanet Sands at Herne Bay. This I at first thought to be probably the perfect condition of *N. cardioides*, which the young or unmutilated portion of that shell somewhat resembles; but upon close comparison the two specimens do not satisfactorily accord. Mr. Edwards has given to this specimen the MS. name of *sextans*, the outline of it forming somewhat irregularly the sixth part of the circle. Fig. 8 *b*, of the same plate is the likeness of a shell in Jermyn Street, from Herne Bay, which may probably belong to the same species, coming, as it does, from the same bed; but I have had it represented in consequence of a difference in outline, it being less triangular than fig. 8 *a*, the dorsal margin on the pedal side being more convex, and the pedilateral margin less pointed. The anal region (which, I think, in general affords a good auxiliary character) is, unfortunately, in this specimen broken.

The recent discovery of these last-noticed specimens has caused considerable delay in the preparation of my work, but they appear of so much interest and of so much importance towards a history of the contents of our Eocene deposits, that I thought it would not be pardonable to pass them over, and now, at the eleventh hour, another shell has come into the possession of Mr. Edwards, which appears to me to be also worthy of especial notice, and I have had it figured.

Tab. XIX, fig. 21.—This last specimen is a very elegant shell; it approaches in form very closely to *N. lavigata* of the Crag, and I have given to it the name *N. praelavigata*, in consequence of its very near relationship. It is excessively thin, quite smooth externally, and it has a margin free from crenulations; it differs from *N. proava* in being thinner, and in having the anal region shorter than in that species; and it differs from *N. lavigata* in having a depression or shallow sulcus on the dorsal region beneath the dental edge; the curvature of the ventral margin, although nearly as great as in the Crag shell, is not quite so regular, and the pedilateral margin being a little broader in our present specimen, will distinguish it. The interior I have not been able to examine. The shell is too thin and too firmly imbedded in the matrix to permit of removal.

LEDA. *Schumacher*, 1817.

Generic Character. Shell equivalve, inequilateral, elongate, lanceolate, or elliptical, sometimes fig-shaped, rounded at the pedilateral margin; siphonal region more or less pointed or rostrated; umbones small, approximate; hinge with numerous sharp, generally angular, and interlocking teeth, separated by a spoon-shaped or triangular fossette; connexus cartilaginous; pallear line sinuated, with a linear impression, more or less distinguished, extending from the middle of the umbonal region to the base of the oral adductor muscle-mark. In the recent state the shell is covered by a thick epidermis.

Animal with the mantle open in front, margins simple, sometimes fimbriated; foot large, discoidal, with serrated edges; siphons slender, unequal, partially united.

This genus is distinguished from *Nucula* by the prolongation or extension of the siphonal region making some of the species equilateral, or even reversing the comparative dimensions, giving the smaller and shorter portion to the pedal side. Möller has subdivided this genus, and proposed the name of *Yoldia* for those shells which gape on each side. These two names are still adopted by some authors, who maintain the distinction to be sufficient for generic division. Mörsch has made another division for those which are closed at both extremities, and for which he proposes the generic name of *Portlandia*, while *Leda* proper is said to gape only on one side. The distinctions here spoken of are, I fear, very unstable, and will probably, by the greater number of conchologists, be considered only of specific value. *Solinella* has a similarly shaped shell, with the dental area furnished with a row of small, sharp, angular teeth on each side of the umbo similar to those of the present genus; but the connector there is wholly ligamental, situate externally upon a projection or fulcrum, and this character fairly entitles the shell in question to generic distinction.

The shells of this genus (*Leda*) are often quite smooth; but some have concentric ridges or thickened lines of growth, and a few are ornamented with ridges in an oblique direction, the inner margins of the shells are at all times free from crenulations.

Species of this genus in the recent state have been found in all parts of the world and in all climates, and at all depths: upwards of seventy have been described; and in the 'Proc. of the Nat. Hist. Soc. of Philadelphia,' 1860, p. 49, Mr. Binney called attention to a species of *Leda* which Dr. Gould says is common to the seas of Japan and to the coast of Massachusetts.

In the fossil state they are also numerous, and have been found low in the Secondary formations.

1. LEDA AMYGDALOIDES, *J. Sowerby*. Tab. XVII, fig. 6, *a—c*.

NUCULA AMYGDALOIDES. *J. Sow.* Min. Conch., t. 554, fig. 4, 1821.

— — *Wetherell.* Tr. Geol. Soc., 1834, p. 134.

— — *Morris.* Catal. Brit. Foss., p. 217, 1854.

Spec. Char. *L. testá elongato-ovatá, crassá, tumidá, sub-æquilaterali; concentricè striatá, striis obtusis rotundis; pedi-regione ovato-rotundatá; siphoni-regione obtusè rostratá; areá dentali crassiusculá; fossulá connexús minutá, profundá.*

Shell elongately ovate, thick, tumid, glossy, nearly equilateral, and concentrically striated; striæ rounded; pedilateral margin ovately rounded; siphonal region obtusely pointed; dental area rather thick; cartilaginous depression small.

Length, 1 inch; *height* $\frac{1}{2}$ an inch.

Localities. Highgate, Potter's Bar, Wandsworth, Sheppey, Hampstead, Southend, Whetstone Park, Finchley, Hornsey (*Edwards* and *Wetherell*), Cuffells (*Prestwich*).

This is an elegant shell, and abundant in some localities, but seldom found with the valves separated. Casts of this shell (at least what appear to be so) are found at Sheppey. The nearest approach to this species is *N. Deshayesiana*, Nyst ('Coq. Foss. Belg.,' p. 221, pl. xv, fig. 8); but that shell differs in being larger, thicker, with a more inflated and more prominent umbo; the striæ in the British shell extend to the extreme margins, and cover the entire surface, as they do also in *N. Deshayesiana*. There is a distinctly marked corselet as well as lunule on each side of the umbo, with an elevated ridge; this is not so distinctly marked in the Belgian shell, and the siphonal region of this latter species is rather the more pointed of the two. There are about fifteen or sixteen denticles on each side of the hinge-area of our shell, and the sinus in the mantle-mark is very shallow.

2. LEDA COSTULATA, *Deshayes*. Tab. XVIII, fig. 3, *a, b*.

LEDA COSTULATA. *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 829, pl. 65, figs. 8—10, 1858.

Spec. Char. *L. "testá ovato-transversá, subtrigoná, solidulá, depressiusculá, æquilaterali, anticè obtusá, posticè vix rostratá, transversim regulariter sulcatá; umbonibus minimis, conniventibus; lunulá lavigatá, vix distinctá; ano elongato, lanceolato, convexiusculo, angulo obtuso separato; margine cardinali angusto; dentibus serialibus minutissimis, approximatis; fossulá ligamenti minutissimá."*—*Desh.*

Shell elongate, ovately subtrigonular, strong, somewhat depressed, equilateral; pedilateral margin ovately rounded; siphonal region scarcely rostrated, covered concentrically with broad ridges and furrows; beaks small; lunule indistinct; corselet elongate, slightly convex, ex-

tending the length of the siphonal region; hinge-area narrow, with a small pit for the connector.

Length, $\frac{1}{4}$ inch; *height*, $\frac{2}{10}$ ths of an inch.

Locality. Bracklesham (*Edwards*).

A single specimen is in the cabinet of Mr. Edwards; it is the only one I have seen, and, judging from the figure and copious description given by M. Deshayes, I feel no hesitation in referring it to this elegant species. I agree fully in opinion with M. Deshayes that it is quite distinct from *Leda striata* of the Paris Basin, and it is still further removed from what has been called *Leda striata* from our own deposits.

The siphonilateral margin of our shell is more rounded and less pointed than that of *L. striata*, and it corresponds in that character both with *L. oblata* and *L. amygdaloides*; but it differs from the former in being *entirely* covered with ridges, and in being also more equilateral; and from the young of the latter in having the ridges much larger and more distant, and in being comparatively shorter. The dental margin is very narrow, and is furnished with about a dozen denticles on each side of the cartilaginous pit, which is also comparatively small; the shell is thin, and the muscle-mark on the siphonal side is large; the external ridges are visible in the interior. Shell nacreous.

3. LEDA GALEOTTIANA, *Nyst.* Tab. XVII, fig. 2, *a, b*.

NUCULA MUCRONATA. *Galeotti*. Mém. Const. Géol. Prov. de Brabant, p. 155, No. 123, 1837.

— — *Nyst.* Coq. Foss. de Belg., p. 223, pl. 18, fig. 3, 1844.

— SERRATA. *J. Sow.* in Dixon's Geol. of Sussex, pp. 93, 170, pl. 2, fig. 9, 1850.

LEDA GALEOTTIANA. *D'Orb.* Prod. de Paléont., t. ii, p. 378, No. 808, 1850.

— — *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 830, pl. 66, figs. 1—3, 1858.

— SERRATA. *Morris.* Catal. Brit. Foss., p. 206, 1854.

Spec. Char. *L. testá minimá, depressá, ovato-lanceolatá, subæquilaterali, pedi-regione ovato-rotundatá, siphoni-regione rostrato-acuminatá; concentricè striatá vel costatá; striis paucis, magnis, elevatis; lunulá lanceolatá paulo excavatá; ano magno, bipartito; umbo-nibus depressis; marginibus integris.*

Shell small, depressed, elongately ovate, nearly equilateral; pedal region ovately rounded; siphonal region angularly pointed; covered with a small number of elevated ridges or lines of growth; lunule elongated and somewhat shallow; beaks depressed, margins smooth.

Length, $\frac{1}{2}$ inch; *height*, $\frac{1}{8}$ th inch.

Locality. Bracklesham (*Edwards*).

France: Damery, Montmirel, Courtagnon (*Desh.*).

Belgium: Les sables de Laecken, de Jette, de Forêt, et de Louvain (*Nyst*).

This elegant little shell appears to be rare. The ridges on the exterior are elevated, distinct, and large, with deep furrows between them; the furrows are nearly as broad as the ridges. On the siphonal region there is a distinct and elevated keel, sloping from the umbo to the extremity of the siphoni-lateral margin.

4. LEDA MINIMA, *J. Sowerby*. Tab. XVII, fig. 7, *a—e*.

NUCULA MINIMA. *J. Sow. Min. Conch.*, t. 192, fig. 8, 1818.

Spec. Char. *L. testá minimá, ovato-lanceolatá, elongatá, tumidá, subæquilaterali, concentricè striatá striis numerosis prominentibus; pedi-regione rotundatá; siphoni-regione rostratá, sub-acuminatá; umbonibus minimis, approximatis; ano magno, lanceolato, angulo mediano bipartito, angulo obtusiore conscripto; cardine crassiusculo, multidentato; fossulá minimá, profundá.*

Shell small, elongately ovate, tumid, nearly equilateral; pedal region rounded, siphoni-lateral pointed; beaks small, approximate, covered with concentric striæ or ridges; corselet distinct, elevated in the centre; dental margin thick, with numerous teeth; cartilaginous support small and deep.

Length, $\frac{1}{4}$ of an inch; *height*, $\frac{1}{7}$ th of an inch.

Locality. Barton, Bracklesham, Bramshaw, Brook, Highcliff (*Edwards*).

There are three or four species of this genus about the same magnitude, possessing many similar characters, which have been found in the British Eocene deposits, and it is somewhat difficult to say which was the one intended by Mr. Sowerby for *N. minima*. The present one is abundant, and probably was the one his figure is designed to represent. He says, "Transversely ovate, convex, transversely striated." The striæ in this species cover the entire surface; they are fine and rounded, extending from the pedilateral margin to the angular ridge on the slope of the siphonal region, beyond which is a large corselet; this is of a lanceolate form, divided by a central ridge, the upper portion of which is finely striated. There is a row of angular teeth (at least a dozen) on each side of the cartilage-pit.

There are two varieties of this shell, one of which strongly resembles the figure of *L. gracilis*, *Desh.* ('An. sans Vert. du Bas. de Par.,' p. 831, pl. 64, figs. 24—26); and several differences are presented, as might be supposed, among our numerous specimens; some have the pedal region almost smooth, as if from abrasion on that part, which is generally buried by the animal in the living state.

5. LEDA OBLATA, *S. Wood*. Tab. XIX, fig. 10.

Spec. Char. *L. testá minimá, elongato-ovatá, oblatá, lævissimá, glabrá, subæquilateralí; pedi-regione tumidá; siphone-regione compressiusculá, margine obtusè rostratá; umbonibus prominulis.*

Shell small, elongately ovate, externally smooth and glossy, slightly inequilateral; pedal region tumid and rounded; siphonal region compressed; obtusely rostrated; beaks slightly prominent.

Length, $\frac{1}{3}$ rd of an inch.

Localities. Chalk Farm (*Wetherell*), Potter's Bar (*Edwards*).

There are a few specimens in Mr. Wetherell's cabinet, and also in Mr. Edwards's, which very much resemble, in outline and general characters, *L. partim-striata* from Highgate and Clarendon; but they differ in having the exterior perfectly smooth and glossy, and appear to be quite free from the ridges which ornament the centre or ventral portion of the shell of that species. This species presents some resemblance to the variety *L. prisca*, from Highgate; but the shell is larger, and the siphoni-lateral margin is not so pointed. The specimens are too closely imbedded in the clay to permit of removal, and the interior is consequently invisible.

6. LEDA PRISCA *Deshayes*. Tab. XVII, fig. 4, *a—d*.

LEDA PRISCA. *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 830, pl. 65, figs. 15—17.

Spec. Char. *L. "testá minimá, obovatá, tumidá, lævigatá, politá, striis incrementi vix conspicuis; anticè rotundatá; posticè angulatá, acutá, cuneatá; umbonibus submedianis, depressis; lunulá ellipticá; dentibus 8—9 utroque angulatis; marginibus integris."*

Shell small, obovate, tumid, or inflated; smooth, glossy, with scarcely visible lines of growth; one side rounded and the other angulated and sharp or wedge-shaped; umbones subcentral, depressed; lunule elliptical; denticles about 8—9 on each side; margins smooth.

Length, $\frac{3}{16}$ ths of an inch; *height*, $\frac{1}{10}$ th of an inch.

Localities. Var. *a*, Highgate (*Wetherell*); var. *β*, Barton (*Edwards* and *S. Wood*).

This pretty little shell is by no means abundant. It strongly resembles *L. pygmaea*, the existing British and Mediterranean species.

There are two British Eocene shells that I think may be assigned to the French species; they differ a little in the number of denticles; the one from Highgate corresponds closely with the description given by M. Deshayes; the other, from Barton, does not appear to have quite so many teeth in the hinge-line. They both differ from

L. pygmaea in being rather more pointed or angulated at the siphoni-lateral margin, with a less elevated umbo, and there is a rather large cartilaginous area and a narrower hinge, the shell also is more tumid.

The Highgate variety of *L. prisca* is most probably *N. minima* of 'Min. Conch.,' t. 192, fig. 9, which Mr. Sowerby suspected might be the cast of another species.

7. LEDA PARTIM-STRIATA, *S. Wood*. Tab. XVII, fig. 1, *a—c*.

NUCULA STRIATA, var. J. Sowerby. Trans. Geol. Soc., 2nd ser., vol. v, pl. viii, fig. 12, 1834.

Spec. Char. *L. testá elongato-ovatá, oblatá, tumidá, tenui, subæquilaterali; pedi-regione convexá, siphoni-regione longiore et obtusè rostratá; in medio longitudinaliter costatá vel sulcatá; utrinque lævigatá; umbonibus prominulis.*

Shell elongately ovate, oblate, tumid, thin, inequilateral; pedal region convex; siphonal region the longer, laterally compressed, and obtusely rostrated; central region longitudinally ridged, with both extremities smooth; beaks slightly prominent.

Length, $\frac{1}{3}$ rd of an inch.

Localities. Clarendon, Highgate, Potter's Bar, Haverstock Hill, Alum Bay (*Edwards*), Hampstead Heath (*Wetherell*).

Although this species appears to have had an extensive geographical range, it is nowhere found in abundance.

The species to which it approaches nearest is *N. amygdaloides*, Sow., from which, however, it differs in being only partially covered with ridges, and it is also more inflated and more obtuse. The ventral region is covered with ridges, but the pedal, as also the siphonal sides, are quite smooth. The shell is tumid only in the pedal and central regions; and compressed on the siphonal side.

8. LEDA PROPINQUA, *S. Wood*. Tab. XX, fig. 2.

Spec. Char. *L. testá minutá, ovato-subtrigonulá, convexiusculá, sub-inæquilaterali, tenui, lævigatá; pedi-regione elongato-ovatá vel semi-ellipticá; siphoni-regione subrostratá et angulatá; umbonibus depressis, utrinquè sub-æqualiter declivis, lunulá anoque vix perspicuis.*

Shell small, ovately triangular, slightly convex, nearly equilateral, thin, and smooth; pedal side elongately ovate or semi-elliptical; siphonal side obtusely rostrated or dorsally angulated; beaks depressed, with nearly an equal slope on each side; lunule and corselet scarcely perceptible.

Length, $\frac{5}{16}$ ths of an inch; *height*, half the length.

Locality. Colwell Bay (*Edwards*).

A single specimen from the above locality is in Mr. Edwards's cabinet, and this I am unable satisfactorily to assign to any other species. I therefore give it the above name provisionally. The species this shell most nearly resembles is *L. oblata*, from Highgate, but the present shell is thinner and flatter; it is also comparatively longer, and the siphoni-lateral margin is more pointed. Our shell appears to be quite smooth upon the exterior, and glossy; the dorsal margin on the pedal side is slightly convex; on the siphonal side it is nearly straight. The specimen is firmly imbedded in the matrix.

9. *LEDA SUBSTRIATA*, *Morris*. Tab. XVII, fig. 5.

LEDA SUBSTRIATA. *Morris*. *Geol. Journ.*, vol. viii, p. 266, pl. 16, fig. 7, 1852.

Spec. Char. *L. testá minimá, ovato-elongatá, subtrigoná, tumidiusculá, sub-inæquilaterali, concentricè striatá aut obtusè costatá; pedi-regione ovato-rotundatá; siphoni-regione longiore, subrostratá et sublævigatá; umbonibus prominulis; lunulá viâ distinctá; ano elongato, lanceolato.*

Shell small, ovately elongate, obtusely trigonular, rather tumid, slightly inequilateral; concentrically striated or obtusely ridged; pedilateral margin ovately rounded; siphoni-lateral obtusely pointed; beaks prominent; lunule ill defined.

Length, $\frac{3}{8}$ ths of an inch; *height*, $\frac{1}{4}$ of an inch nearly.

Locality. Richborough (*Prestwich*), Pegwell Bay (*Edwards*).

"This shell, collected by Mr. Prestwich from the Thanet sands at Richborough, Castle and Pegwell Bay, is difficult to distinguish from *Nucula striata*, Lam., which it resembles in general form, but is rather longer in a transverse direction, and the striæ differ a little, and are interrupted towards the posterior margin in some of the specimens examined."—*Morris*.

In addition to the above remarks I may observe, that the French shell has different proportions: the siphonal region is rather less than the pedal, whereas in the British shell it is the reverse. This species appears still more to differ from *Leda minima*, which has a distinct and well-marked anal or corselet region, with a defined and prominent ridge, and the siphoni-lateral margin is in that shell more pointed than in either our present species or the French shell *L. striata*.

UNIO. *Phillippon*, 1788.

Generic Character. Shell equivalve, inequilateral, generally thick and externally smooth, occasionally corrugated or ornamented with nodules or spines; aged specimens sometimes become ponderous. Covered by an epidermis in the living state; eroded at the umbones; hinge with two short cardinal teeth in the left valve, and one, sometimes two, in the right, and one elongated lateral tooth beneath the dorsal margin. Impressions

by the adductors large and deep; pedal muscle-marks distinct—one double, situate near and below the oral, the other single, and above the anal adductor; mantle-mark without a sinus; shell nacreous; connexus ligamental.

Animal with the margins of the mantle disunited, except between the siphonal openings; tubes short—one fringed, the other plain; foot compressed.

Variations in the fresh-water mussels are numerous and excessive, and many genera, with very ill-defined lines of distinction, have been proposed for their reception. Unios are of a peculiar construction, being formed almost entirely of nacre; and some of the recent species not only display a beautiful pearly lustre, but are of a purple, pink, or salmon colour in the interior. Colour, Mr. Lea says, is not always to be depended upon for a specific distinction.

This genus is found in the Wealden formation, and is said to have been in existence during the Carboniferous period.

Mr. Lea, who is our best authority on this subject, says of this genus that there are already described, as inhabiting the rivers, lakes, and pools of the United States and Territories, 465 species, to which several more in his own cabinet will have to be added; and he considers that there are upwards of 600 species belonging to the family Unionidæ that are peculiar to North America. This large number is, perhaps, the more extraordinary when compared with the number of existing species on our own continent. Mr. Lea further says ('Proc. Acad. Nat. Sc. Philad.,' p. 3, 1860), that he had taken great pains to procure specimens from all parts of Europe, "and he was satisfied that there were ninety-eight synonyms made by European authors for the single species *Anodonta cygnea*, Drap. (*Mytilus cygneus*, Linn.), and that the synonymy is nearly as profusely erroneous in *Unio pictorum*, *Unio tumidus*, *Unio Batavus*, and *Unio littoralis*." The number of recent species he has allotted to Europe is seven *Uniones*, one *Margaritacea*, one *Monocondylea*, and one *Anodonta*. This great discrepancy between the numbers on the two continents gives to North America a preponderance of sixty-fold over those of Europe. The extent of fresh water in the rivers and lakes of America may in some degree be assigned as a cause for the very great development of species in that continent over those in Europe; but that alone appears insufficient for explanation, as the proportions of fresh water between the two continents will not bear a comparison with this disproportion of species, more especially when we consider that it is principally on the shores of these extensive lakes, or at least in not very deep water, that we are likely to find living many of the species, and can hardly take into our computations the fresh-water area of North America. This would materially reduce the apparent excess in the area of feeding-ground for these animals in America over that in Europe, and it does appear to me that some other cause than mere difference in the superficial extent of the medium in which they live, is required to account for this great difference in the relative number of the species found in the two Continents. We have, according to Mr. Lea, ninety-eight synonyms in a single European species, thereby implying very great variation; but to what extent we are permitted to

carry our opinions respecting what amounts to simple variation and what constitutes specific distinction will probably long be matter for dispute. The differences in America, considered sufficient for specific isolation according to this author, appear to be more clearly defined than they are with us. We have nothing in other sections of the Mollusca, either marine or terrestrial, that will bear a comparison with such an enormous difference in the number of species as is alleged to be exhibited in this family, and if correct (and I am not able to say that it is otherwise) it is an anomaly in the history of the Mollusca.

The remains of fresh-water deposits of any past period give comparatively a very limited number of species in this family, bearing in that respect a resemblance to the dissemination of these animals on the continent of Europe. I have here figured seven species from the Eocene deposits of England, but these are not at all well defined; and there are nine or ten in those of France. The Upper Tertiary species are, I believe, still existing. We might, perhaps, expect that the limited number of living species should have descended from a limited number of their predecessors; but the fresh-water Tertiary deposits of America appear also to have been but sparingly supplied by these animals, while the specific development in this family at the present day in America is out of all proportion when the present is compared with the past, as is here attempted to be done with the Tertiaries of Europe and their descendants.

M. Deshayes considers one of the French Eocene shells *U. Michaudi*, to be very closely related, probably the same, as a living species in North America, *U. cicatricosus*; but I have not been able to identify any one of our own. This may arise from a want of acquaintance with the numerous existing species of the American waters, where almost every conceivable form of the genus is represented. On a comparison with the figures and descriptions of the existing shells, given by Mr. Lea, there may be pointed out two or three which very closely resemble those of British Eocene species; and when each comes to be better known, and the specimens themselves compared, it is possible that one or more may be found to have retired from England in the direction of America after the Eocene period, through land, or rather rivers, that probably existed at that time on the western side of the Eocene sea of Europe, such as has been the case with peculiar genera of fresh-water fish and reptiles now confined to the American continent. Our own fossils in this genus, from the older Tertiaries, are generally far from being in a perfect state of preservation, so that no fair comparison can be made or relied upon. The specific separations here proposed must for the present be considered merely as provisional; for with the fate of an existing European species before our eyes, with its ninety-eight synonyms, it would be hazardous in the extreme to pronounce decisively upon the few and in most instances imperfect specimens hitherto obtained from our Eocene deposits.

1. UNIO AUSTENII, *Forbes*, MS., and *Morris*. Tab. XX, fig. 12.UNIO AUSTENII. *Morris*. Mem. Geol. Surv., p. 147, pl. 2, fig. 7, 1856.

Spec. Char. “*Testá oblongá, ovali, modioliformi, posticè obtusè rotundatá; margine dorsali leviter arcuato; margine ventrali subrecto; umbonibus ferè terminalibus.*”

“An oblong, depressed, modioliform shell, somewhat expanded, and rounded posteriorly; the umbones are depressed and nearly terminal; the surface is but obscurely striated.”—*Morris*.

Locality. Hempstead.

The only specimen that I have seen is the one which enriches the Museum in Jermyn Street, and on which the species has been established. The principal character of distinction appears to me to be its inequilaterality, which is in excess.

2. UNIO EDWARDSII, *S. Wood*. Tab. XX, fig. 16, *a, b*.

Spec. Char. *U. testá elongato-ovatá aut elongato-cuneatá, crassá, irregulariter et concentricè sulcatá vel corrugatá, inæquilaterali, convexiusculá; pedi-regione obtusè rotundatá; siphoni-regione valdè longiore et obtusè acuminatá; margine ventrali subcurvato.*

Shell elongately ovate or wedge-shaped, thick, and irregularly ridged by lines of growth, slightly convex or tumid; pedilateral margin obtusely rounded; siphonal region much the longer and roundedly pointed; ventral margin slightly curved.

Length, $2\frac{1}{4}$ inches; *height*, $1\frac{1}{4}$ inch.

Locality. Peckham (*Edwards*).

Specimens of this species are few and imperfect, but the form is peculiar, differing from that of any other Eocene species; it much resembles *U. pictorum*, but it is not sufficiently pointed on the siphonal side, and it is more inequilateral. One of our figures represents a specimen that has lost nearly the whole of the shell, but it gives a very good representation of the outward form; and the other figure shows the exterior to have been more than usually rugged or corrugated, from which circumstance the specimens have had attached to them in Mr. Edwards's cabinet the MS. name of *corrugata*, which I should have adopted, had it not been employed for a recent species in America. I therefore propose for our shell the name of the Author of the ‘Monograph on the Eocene Mollusca.’

3. UNIO GIBBSII, *Forbes*, MS., and *Morris*. Tab. XX, fig. 14.UNIO GIBBSII. *Morris*. Mem. Geol. Survey, p. 147, pl. 2, fig. 6, 1836.

Spec. Char. “*Testá elongato-ovatá, transversá, utrâque extremitate obtusá, sed posticè obscurè angulatá; margine ventrali subrecto.*”

“ An ovate, elongate, or somewhat quadrate shell, with the anterior extremity rather more rounded than the posterior, which is slightly angulated and truncated.

“ The specimen figured has undergone some compression, which has partially modified the original form. It was considered, and therefore figured, as a distinct species by Professor E. Forbes ; it is, however, closely allied to and difficult to distinguish from some varieties of *U. Solandri*.”—*Morris*.

Locality. Hempstead Cliff.

I am much inclined to think, with Professor Morris, that it is only a variety (and that not a very distinct one) of *U. Solandri*.

4. UNIO SOLANDRI, *J. Sowerby*. Tab. XX, fig. 11, *a, b*.

UNIO SOLANDRI. *J. Sow. Min. Conch.*, t. 517.

— — *S. Wood. Catal. in Lond. Geol. Journ.*, p. 118. 1847.

— — *Wright. Ann. and Mag. Nat. Hist.*, June, 1851, p. 6.

— — *Morris. Catal. Brit. Foss.*, p. 230, 1854.

Spec. Char. *U. testá transversá, oblongá vel subrhomboidali, compressá valdè inequilaterali; pedi-regione rotundatá, siphoni-regione truncatá; valvis tenuibus; umbonibus vix prominentibus; dente cardinali parvo, laterali elongato; striis crescentibus exilissimis.*

Shell transversely ovate, oblong, and slightly compressed, very inequilateral ; pedilateral margin rounded, the opposite one somewhat angularly truncated ; valves thin ; umbones depressed ; cardinal hinge-tooth small, with an elongated lateral tooth ; connexus short ; lines of increase very fine.

Length, $1\frac{3}{4}$ inch, *breadth*, $\frac{7}{8}$ ths inch.

Localities. Hordwell, Colwell Bay.

Although so common as this shell is at Hordwell, it does not appear to have been known to Solander, at least he does not figure it.

The shell called *Mya pictorum*, Foss. Hant. fig. 95, referred to in ‘*Min. Conch.*,’ vol. vi, p. 29, with a ? , is probably *Cytherea lævigata*. The shells at Hordwell are in great profusion, but they are exceedingly fragile, and generally exfoliated, so that it is very difficult to obtain a perfect specimen. The proportions in magnitude of this shell are generally about two in length to one in height, and rather more than half a one in thickness or tumidity. The dorsal and ventral margins are nearly parallel, or with a very slight curve inwards in the ventral margin, and the siphonal is three times the length of the pedal region. In the right valve there is one rather prominent tooth a little on the pedal side of the umbo, and this is obsolete in the left valve ; the elongated lateral tooth is the reverse of this, being prominent in the left valve and obsolete in the right. The oral muscle-mark is of a moderate

size, deeply impressed, and there is a distinct pedal one within and a little below it; the anal one large and remote; the umbones are rugose, and generally eroded. The epidermis is visible on well-preserved specimens, which have also the connector entire, extending from the umbo about half the length of the shell.

A large portion of the stratum in which these shells abound at Hordwell is a marly bed, but I obtained a few perfect specimens from a pure siliceous sand.

5. UNIO SUBPARALLELA, *Edwards*, MS. Tab. XX, fig. 13, *a*, *b*.

UNIO DESHAYESII? *Prestwich*. Quart. Journ. Geol. Soc., 1854, p. 118.

Spec. Char. *U. testá elongatá, sub-quadrangulatá vel ovato-oblongá, lævigatá, depressá, valdè inæquilaterali; pedi-regione brevi, rotundatá; siphoni-regione longiore, subangulatá vel obliquè truncatá; umbonibus depressis; marginibus ventrali et dorsali subparallelis.*

Shell transversely elongate, or ovately oblong, smooth, depressed, very inequilateral; pedilateral margin rounded; siphonal region much the larger, slightly angulated or obliquely truncated; umbones depressed; dorsal and ventral margins nearly parallel; ventral margin slightly incurved.

Length, $2\frac{1}{4}$ inches; *height*, $\frac{13}{16}$ ths of an inch.

Localities. Peckham (*Edwards*), Counter Hill, Deptford (*Prestwich*).

The specimen referred to *U. Deshayesii* by Mr. Prestwich most probably belongs to the same species as the one here figured, but "its mutilated condition would not permit of determination."

In comparing our present species with the *U. Wateleti* (olim *U. Deshayesii*), the differences appear too great to permit of their being united, and I have therefore adopted the MS. name that was attached to Mr. Edwards's specimen.

I am the more disposed to this separation, because I have not only the figures and description of the French shell in the valuable work by M. Deshayes, but there is also a specimen in the cabinet of Mr. Edwards, sent from France by the author of the species.

A shell from the "Terrain de lignite" in the South of France has been figured and described by M. Matheron under the name of *Unio galloprovincialis*; 'Cat. meth. et descr. des corps organ. foss. des Bouches du Rhone,' p. 168, Pl. 23, fig. 1, which appears from representation very closely to resemble our own, and when the specimens themselves can be compared, may probably be found to belong to the same species. The only difference I can observe on comparing the figure is that the umbo of the French fossil is rather the more prominent of the two.

6. UNIO TUMESCENS, *Edwards*, MS. Tab. XX, fig. 17, *a*, *b*.

Spec. Char. *U. testá transversá, irregulariter ovatá, tumidiusculá, valdè inæquilaterali, lævigatá; pedi-regione convexá, siphoni-regione productá, subcuneatá; umbonibus prominulis; lunulá sub-excavatá; cardine angusto, dente cardinali obtuso, dente laterali elongato.*

Shell transverse, irregularly ovate or ovately wedge-shaped, somewhat tumid, very inequilateral; pedal region rounded, siphonal region produced; umbones slightly prominent and rugose; lunule shallow; cardinal teeth obtuse, lateral tooth elongated and narrow.

Length, $1\frac{3}{4}$ inch.

Locality. Headon Hill (*Edwards*).

A few specimens corresponding to the above characters are in Mr. Edwards's cabinet, which he has considered to be distinct. I am unable to refer them to any published species.

7. UNIO VECTENSIS, *Edwards*, MS. Tab. XX, fig. 15.

Spec. Char. *U. testá obtusè ovatá, vel ovato-rotundatá, inflatá, gibbosá, crassá, lævigatá; umbonibus magnis, sub-prominulis; pedi-regione rotundatá, siphoni-regione obliquè truncatá vel obtusè angulatá; margine dorsali convexiusculá; margine ventrali sub-planatá.*

Shell obtusely ovate or ovately rounded, inflated, thick, smooth; beaks slightly prominent; pedilateral margin rounded, siphonilateral obliquely truncated or sloping and rounded; pedal region one third the length of the shell; dorsal margin convex; ventral margin slightly curved.

Length, $1\frac{1}{2}$ inch; *height*, 1 inch.

Locality. Headon Hill, (*Edwards*).

I have seen but one specimen, and this appears to be so very different in outline that, with Mr. Edwards, I believe it to be quite distinct; I have therefore adopted the MS. name he has given to it.

Tab. XX, f. 19, represents a specimen of this genus from Headon Hill which I cannot satisfactorily assign to any of the foregoing, or to any other species known to me; at the same time I am unwilling to consider it as entitled to a distinct specific position. I think it possible it may be a distortion, and until better specimens be found it must remain under the name of *U. tumescens* var. *Headonensis*.

CORRIGENDA

For *Ostrea prona*, ante p. 29, read *Ostrea ventilabrum*, Goldf.

Ostrea pulchra, p. 30, this name should be restricted to the small shell from Bromley ; the large shell from Reading, figured in Tab. I, is probably a distinct species, which might be called *Ostrea pulcherrima*.

TABLE XIV.

FIG.

- 1, *a—f.* *Arca biangula*, *page* 80.
c. specimen from Barton, var. *Branderi*, with ventral margins closed. Mus.
 Edwards.
f. specimen from Bracklesham, with large gape. Mus. Edwards.
 2, *a, b.* *Arca planicosta*, *p.* 81. „
 3, *a—f.* *Arca appendiculata*, *p.* 79. „
a, b. var. *duplicata*. „
d—f. specimen with area of connexus plain on the pedal side. Mus.
 Edwards.
 4, *a, b.* *Arca depressa*, *p.* 82. Mus. Brit.
 5, *a, b.* *Arca modioliformis*, *p.* 88. Mus. Edwards.

The lines denote the size of the specimens represented.

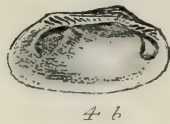
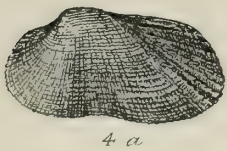
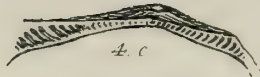
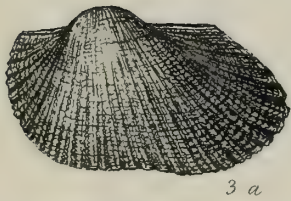
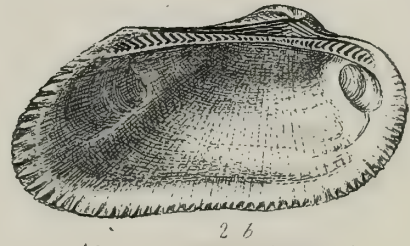
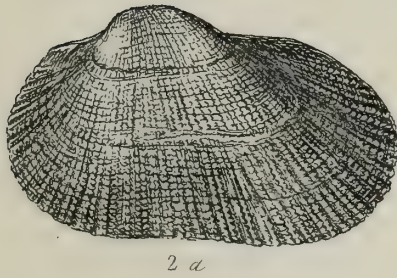
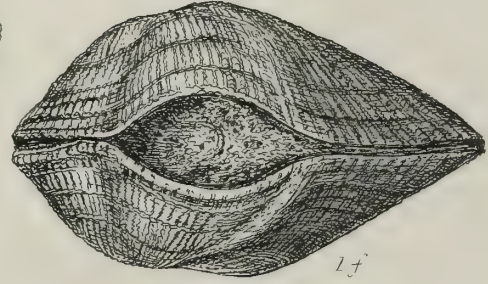
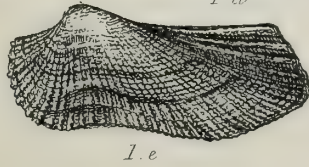
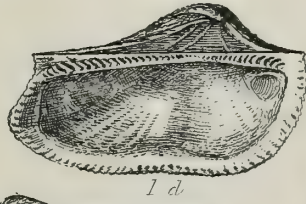
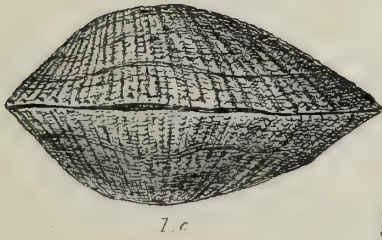
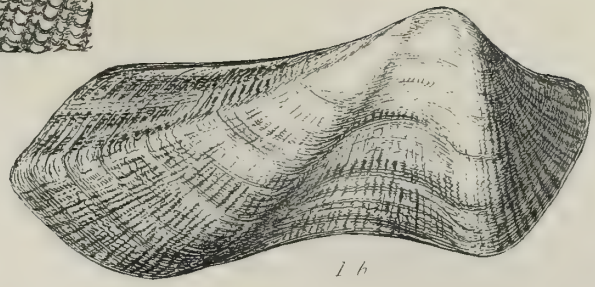
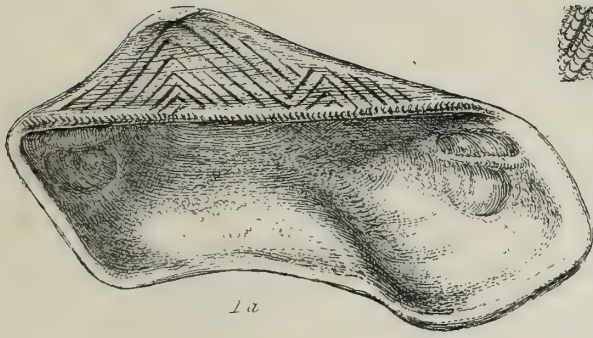


TABLE XV.

FIG.

1. *a, b.* *Arca tumescens*, *page* 92. Mus. Edwards.
2. *a, b.* „ *interrupta*, *p.* 85. „
3. „ *eximia*, *p.* 83. „
4. *a, b.* „ *impolita*, *p.* 84. „
- c.* „ — ? var. Mus. Wetherell.
5. *a, b.* „ *nitens*, *p.* 88. Mus. Edwards.
6. *a, b.* „ *Dulwichiensis*, *p.* 82. „
7. *a, b.* „ *Laekeniana*, *p.* 80. „
- c.* „ — ; var. *cylindrica*. Mus. Fisher.
8. *a, b.* „ *lævigata*, *p.* 86. Mus. Edwards.
- c.* „ — ; hinge greatly enlarged.
9. *a, b.* „ *globulosa* ? *p.* 84 Mus. Edwards.
- c.* „ — ; hinge greatly enlarged.
10. *a, b.* „ *tegulata*, *p.* 90. Mus. Edwards.
11. „ *Websteri*, *p.* 92. „
- a.* „ — ; outside view of a specimen with less elevated siphonal region.
- b, c.* „ — ; outside and inside views of another specimen.
12. *a, b.* „ *Lyelli* var. *contorta*, *p.* 87. Mus. Edwards.
13. *a, b.* „ — „ *lamellosa*. „
14. *a, b.* „ *tessellata*, *p.* 91. „
15. „ *Dulwichiensis* ? *p.* 82. Mus. Prestwich.

The lines indicate the size of the specimens.

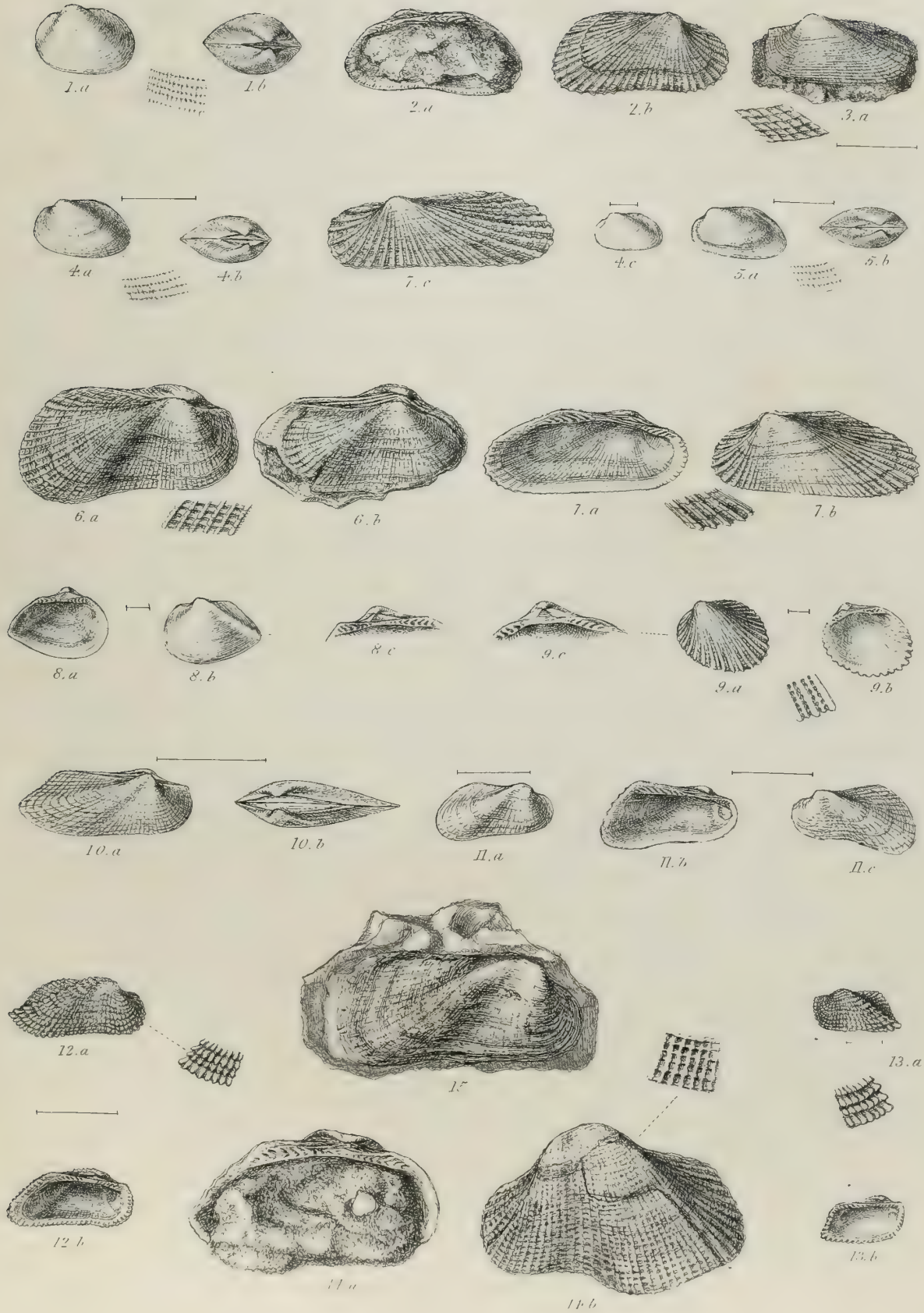


TABLE XVI.

FIG.

1. <i>a, b.</i>	<i>Pectunculus quasi-pulvinatus</i> , <i>page</i> 100.	Mus. Edwards.
2. <i>a, b.</i>	„ <i>pulvinatus</i> , <i>p.</i> 99.	„
3. <i>a, b.</i>	„ <i>deletus</i> , <i>p.</i> 97.	„
4. <i>a, b.</i>	„ <i>spissus</i> , <i>p.</i> 101.	„
5. <i>a—c.</i>	„ <i>proximus</i> , <i>p.</i> 99.	„
6. <i>a, b.</i>	„ <i>Plumsteadiensis</i> , <i>p.</i> 98.	Mus. Brit.
7. <i>a—d.</i>	„ <i>decussatus</i> , <i>p.</i> 96.	Mus. Wetherell.
8.	„ <i>brevirostris</i> , <i>p.</i> 95.	Mus. Edwards.
9.	„ <i>globosus</i> , <i>p.</i> 98.	Mus. Brit.
10.	„ <i>brevirostris?</i> <i>p.</i> 95.	Mus. Edwards.

The lines indicate the size of the specimens.

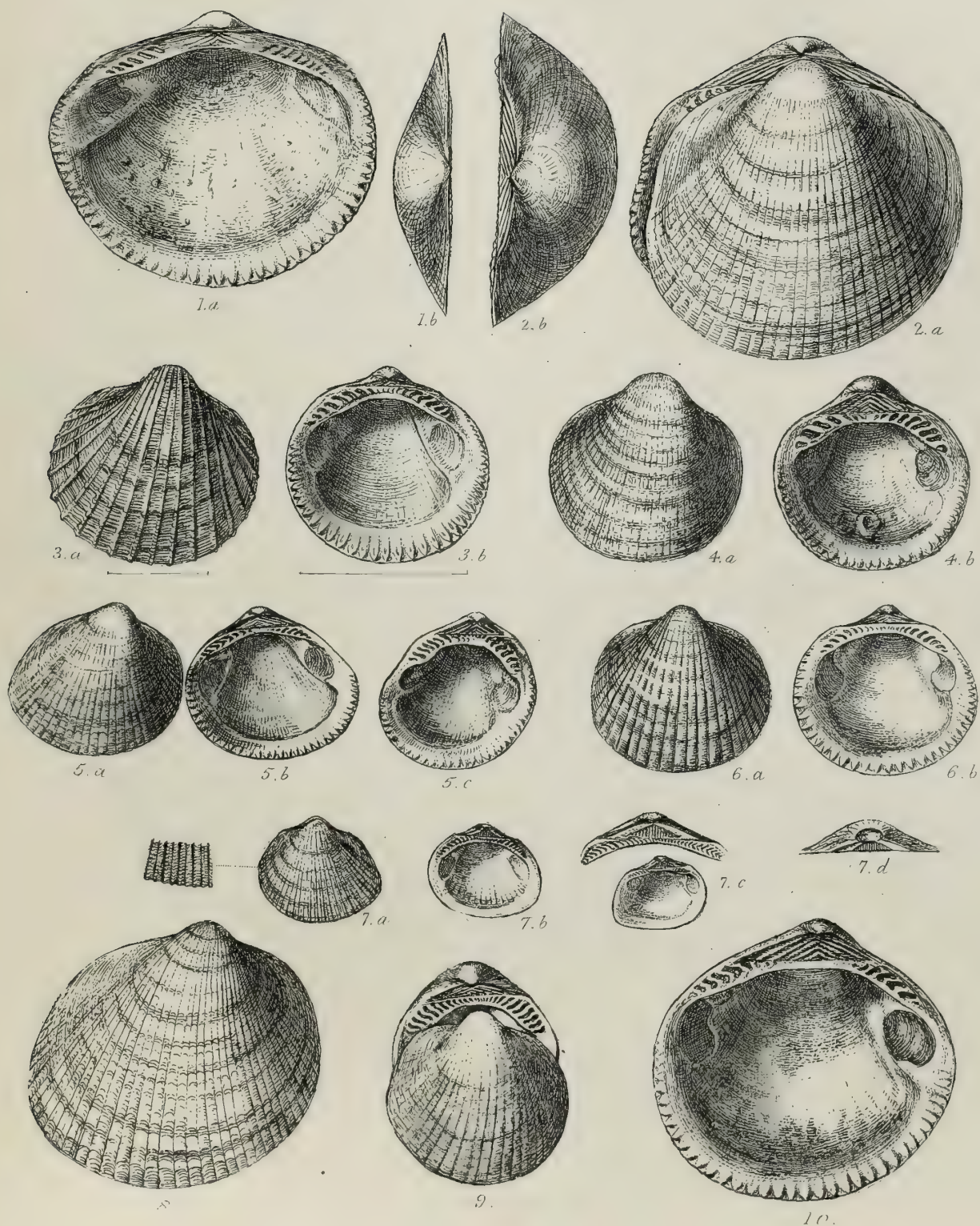


TABLE XVII.

FIG.

1. *a—c*. *Leda partim-striata*, *page* 129. Mus. Edwards.
2. *a, b*. „ *Galeottiana*, *p.* 126. „
3. *a, b*. „ *costulata*, *p.* 125. „
4. *a—c*. „ *prisca*, *p.* 128. „
- d*. „ — ; from Highgate. Mus. Wetherell.
5. „ *substriata*, *p.* 130. Mus. Prestwich.
6. *a—c*. „ *amygdaloides*, *p.* 125. Mus. Edwards.
7. *a, b, c*. „ *minima* var. *a. gracilis*, *p.* 127. „
- c, d*. „ „ *β communis*. „
8. *b. c*. *Cucullæa decussata*, *p.* 93. „
- a*. „ Mus. Bowerbank.
9. *a, b*. *Limopsis scalaris*, *p.* 104. Mus. Edwards.
10. *a, b*. „ *granulata*, *p.* 103. „
11. *a, b*. *Pectunculus proximus*, *p.* 99. Mus. Fisher.

The lines indicate the size of the specimens.

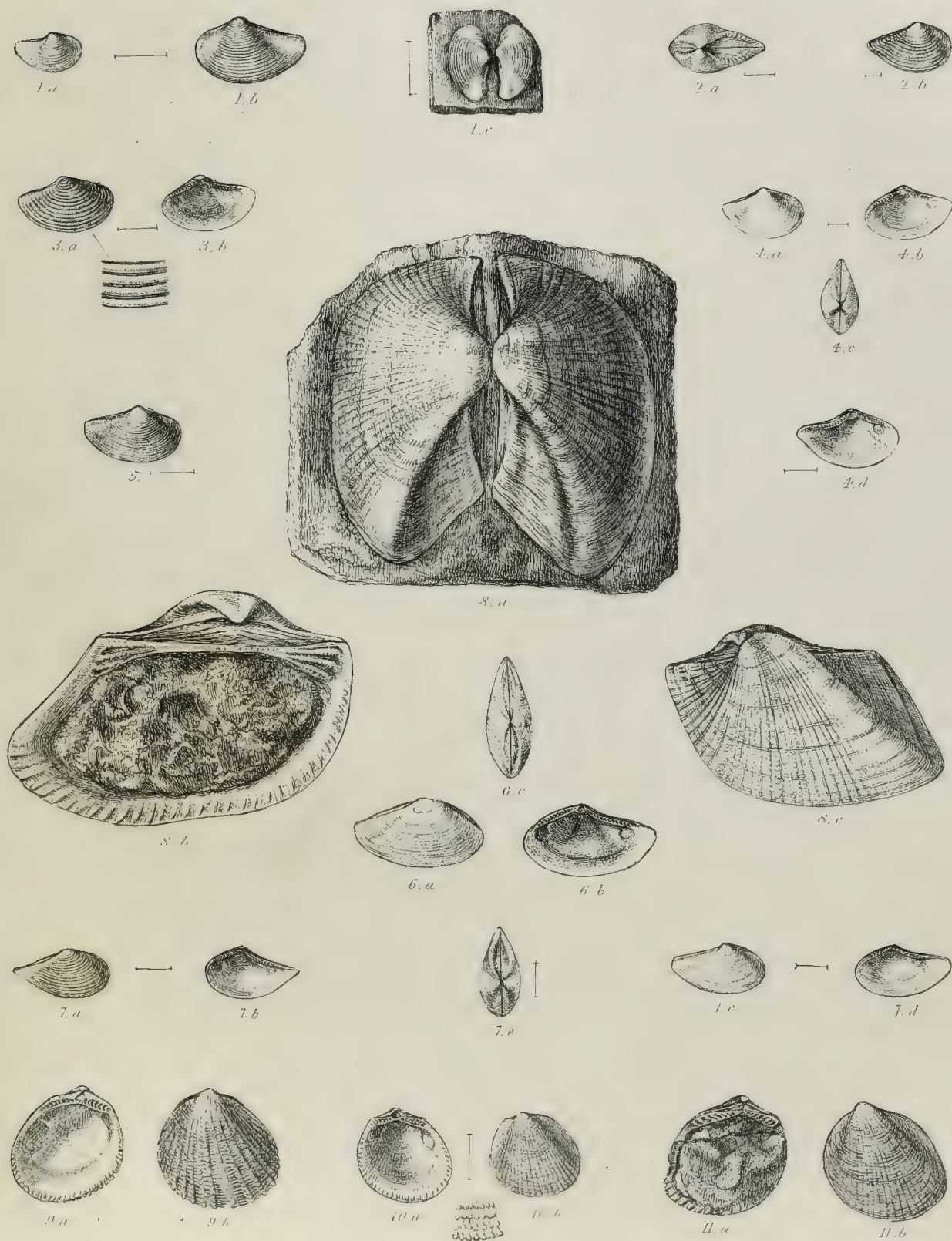


TABLE XVIII.

FIG.

1.	<i>a—c.</i>	<i>Nucula tumescens</i> , <i>page</i> 121.	Mus. Edwards.
2.		„ <i>sphenoides</i> , <i>p.</i> 119.	„
3.	<i>a, b.</i>	„ <i>Headonensis</i> , <i>p.</i> 113.	„
4.	<i>a, b.</i>	„ <i>lissa</i> , <i>p.</i> 113.	„
5.	<i>a, b.</i>	„ <i>ampla</i> , <i>p.</i> 108.	„
6.	<i>a, b.</i>	„ — <i>var. contigua</i> , <i>p.</i> 108.	„
7.	<i>a—c.</i>	„ <i>Dixoni</i> , <i>p.</i> 112	„
8.	<i>a, b.</i>	„ — <i>var. planiuscula</i> , <i>p.</i> 112.	„
9.		„ — <i>var. quadrans</i> , <i>p.</i> 112.	„
10.		„ <i>minor</i> , <i>p.</i> 114.	„
11.	<i>a, b.</i>	„ <i>similis</i> , <i>p.</i> 118.	„
	<i>c.</i>	„ — <i>var. trigona</i> , <i>p.</i> 118.	„
12.	<i>a, b.</i>	„ <i>curvata</i> , <i>p.</i> 112.	„
13.	<i>a—c.</i>	„ <i>bisulcata</i> , <i>p.</i> 109.	„
14.	<i>a, b.</i>	„ <i>Bowerbankii</i> , <i>p.</i> 109.	„
15.		„ <i>protracta</i> , <i>p.</i> 117.	„

The lines indicate the size of the specimens.

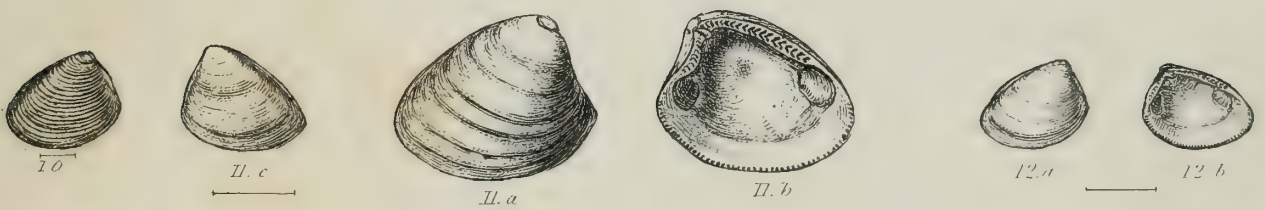
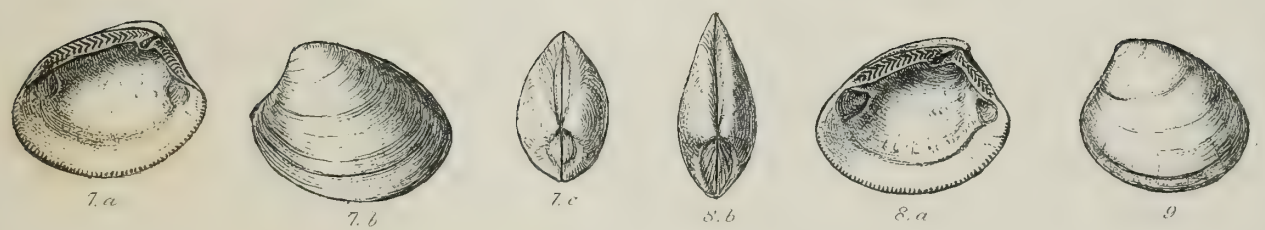
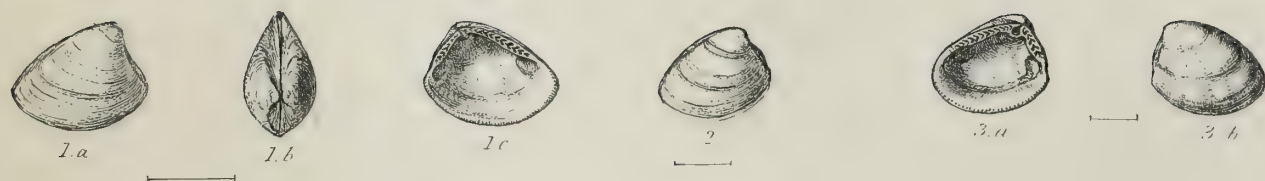


TABLE XIX.

FIG.

1. *a, b.* *Nucula praelongata*, *p.* 116. Mus. Edwards.
2. *a, b.* „ *sphenoides*, *p.* 119. „
3. „ *sericea*, *p.* 120. „
4. *a, b.* „ *praelonga*, *p.* 115. „
5. „ *compressa*, *p.* 110. „
6. „ *Thanatiana*, *p.* 121. „
7. *a, b.* „ *consors*, *p.* 111. Mus. Wetherell.
8. „ *cardioides*, *p.* 110. Mus. Edwards.
9. *a, b.* „ *Wetherellii*, *p.* 121. Mus. Wetherell.
10. *Leda oblata*, *p.* 128. „
11. *a—c.* *Trigonocœlia deltoidea*, *p.* 105. Mus. Edwards.
12. „ *cancellata*, *p.* 106. „
13. *Nucula subtransversa*, *p.* 120. Mus. Fisher.
14. *a—c.* *Pectunculus decussatus*, *juv.*, *p.* 97. Mus. Edwards.
15. *Modiola* ? *subcancellata*, *p.* 77. „
16. *Modiola* ? *crassistriata*, *p.* 75. „
17. „ ? *consobrina*, *p.* 76. Mus. Fisher.
18. „ ? *Bartonensis*, *p.* 75. Mus. Edwards.
19. „ *Deshayesiana* ? *p.* 76. „
20. „ *subcarinata* ? *p.* 77. „
21. *Nucula prælævigata*, *p.* 123. „

The lines indicate the size of the specimens.

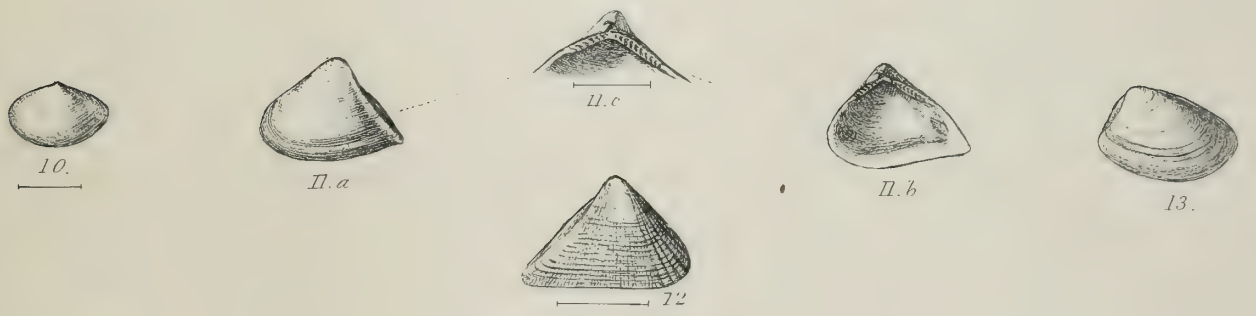
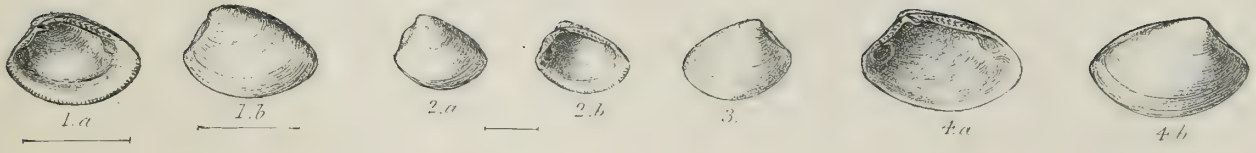
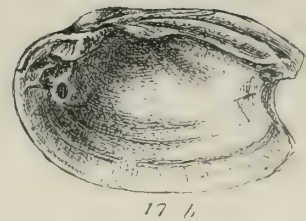
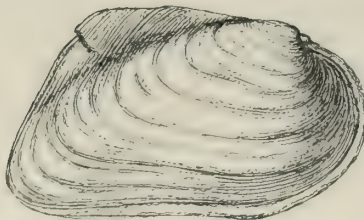
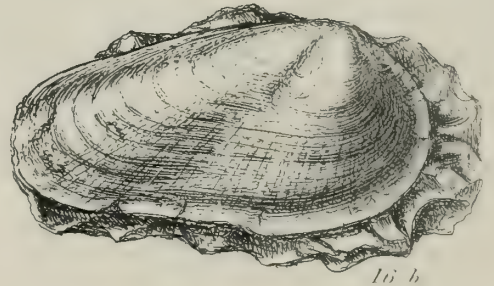
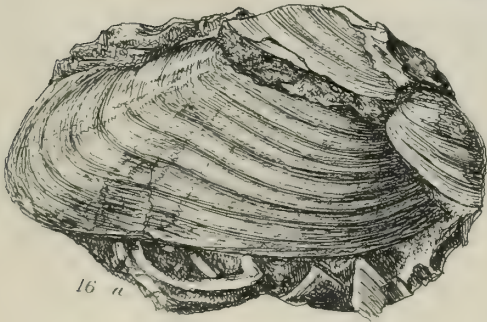
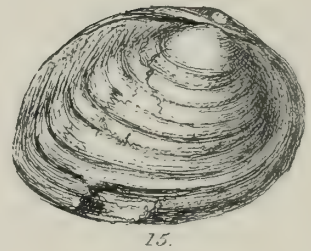
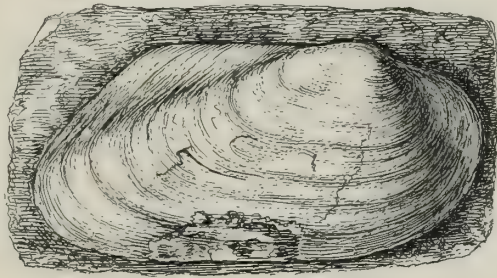
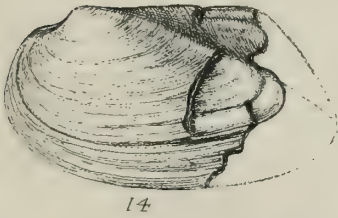
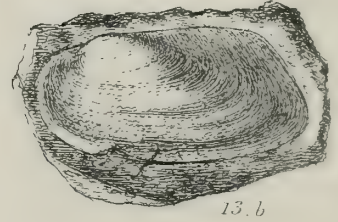
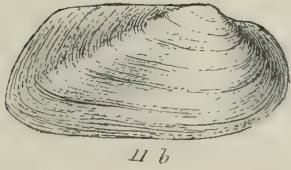
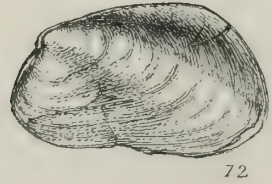
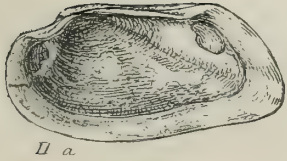
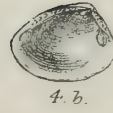
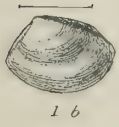


TABLE XX.

FIG.	
1.	<i>Nucula lissa</i> , <i>p.</i> 113. Mus. Edwards.
<i>a.</i>	„ „ var. <i>normalis</i> , <i>p.</i> 113. Mus. Edwards.
<i>b.</i>	„ „ „ <i>transversa</i> , „ „
<i>c.</i>	„ „ „ <i>abnormis</i> , „ „
2.	<i>Leda propinqua</i> , <i>p.</i> 129. „
3. <i>a, b.</i>	<i>Nucula proava</i> , <i>p.</i> 117. Mus. Jermyn Street.
4. <i>a, b.</i>	„ <i>nudata</i> , <i>p.</i> 115. Mus. Edwards.
5.	„ <i>sphenoides</i> , <i>p.</i> 119. „ View to show tumidity and anal region.
6.	„ <i>gracilenta</i> , <i>p.</i> 122. Mus. Meyer.
7.	„ <i>consobrina</i> , <i>p.</i> 122. Mus. Prestwich.
8. <i>a.</i>	„ <i>sextans</i> , <i>p.</i> 123. Mus. Edwards.
<i>b.</i>	„ id. ? <i>p.</i> 123. Mus. Jermyn Street.
9.	„ <i>striatella</i> , <i>p.</i> 123. „
10.	„ <i>venusta</i> , <i>p.</i> 122. Mus. Prestwich.
11. <i>a, b.</i>	<i>Unio Solandri</i> , <i>p.</i> 134. Mus. Edwards.
12.	„ <i>Austenii</i> , <i>p.</i> 133. Mus. Jermyn Street.
13.	„ <i>subparallelus</i> , <i>p.</i> 135.
<i>a.</i>	Specimen from Counter Hill pits, Deptford. Mus. Prestwich.
<i>b.</i>	„ Peckham. Mus. Edwards.
14.	„ <i>Gibbsii</i> , <i>p.</i> 133. Mus. Jermyn Street.
15.	„ „ ? var. <i>Headonensis</i> , <i>p.</i> 133. Mus. Edwards.
16.	„ <i>Vectensis</i> , <i>p.</i> 136. „
17. <i>a, b.</i>	„ <i>Edwardsi</i> , <i>p.</i> 133. „
18. <i>a, b.</i>	„ <i>tumescens</i> , <i>p.</i> 135. „
19.	<i>Pectunculus terebratularis</i> , <i>p.</i> 101. „



THE
PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON :

MDCCCLXIV.

MONOGRAPH
OF
THE FOSSIL REPTILIA
OF THE
CRETACEOUS FORMATIONS;

INCLUDING
SUPPLEMENT No. II.
CRETACEOUS SAUROPTERYGIA.

SUPPLEMENT No. III.
IGUANODON.

BY
PROFESSOR OWEN, F.R.S., F.L.S., F.G.S., &c.

LONDON:
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SUPPLEMENT (No. II)
TO THE
MONOGRAPH
OF
THE FOSSIL REPTILIA
OF THE
CRETACEOUS FORMATIONS.

ORDER—SAUROPTERYGIA, *Owen*.

Genus—PLESIOSAURUS, *Conybeare*.

IN former Monographs and works are given descriptions of the following species of *Plesiosaurus* from Cretaceous deposits :

- PLESIOSAURUS CONSTRICTUS, *Owen*. 'Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' 4to, 1850, p. 398, pl. xxxvii, figs. 6 and 7. From Steyning Chalk-pit, Sussex.
- PLESIOSAURUS BERNARDI, *Owen*. Op. cit., p. 396, pl. xxxvii, figs. 8, 9. From the Upper Chalk, Houghton Pit, near Arundel, Sussex.
- PLESIOSAURUS PACHYOMUS, *Owen*. Monograph, Palæontographical Society, 4to, 1851, p. 64, tabs. xx, xxi. From the Upper Green-sand at Reach, near Cambridge.
- PLESIOSAURUS LATISPINUS, *Owen*. 'Descriptive Catalogue of the Fossil Remains of *Reptilia* and *Pisces* in the Museum of the Royal College of Surgeons of England,' 4to, 1854, p. 63, No. 251.

PLESIOSAURUS NEOCOMIENSIS, *Cpche.* 'Description des Fossiles du Terrain Cretacé des Environs de Sainte-Croix,' 4to, 1858—1860, par N. J. Pictet and G. Campiche, p. 12, pl. vi.

The following are descriptions of other species of Cretaceous *Plesiosaurs*, with additional illustrations of already indicated species :

PLESIOSAURUS PLANUS, *Owen.* *Vertebral Centrums*, Tab. I, II, and III.

The cervical centrum selected for the figures 1—4, Tab. I, gives the characters afforded by this instructive part of the vertebral column of a *Plesiosaurus*. The flatness, both of the under (fig. 4) and of the terminal articular surfaces (fig. 2), suggested the name distinguishing the species, or at least the vertebræ by which alone this cretaceous Plesiosaur has hitherto been exemplified. The costal surfaces (Tab. I, figs. 1, 2, and 4, *pl*) are of a narrow, oblong figure, formed, as it were, by truncation of the lower angles of the triangular centrum, of which the apex has been more broadly removed by the sections, leaving the neural (*ib.*, *n*) and neurapophysial (*np*) surfaces above. If the borders of the costal surface have projected with a sharper definition, they have been abraded, as, indeed, is most probable ; almost all the bones derived from the stratum of Cambridgeshire phosphatic Green-sand being more or less rubbed or worn, either in the original imbedding, or subsequently by the mechanical appliances by which the phosphatic nodules are extracted. I have selected the centrum which has been least subject to this attrition, from a large series of the present species. Subsequent observers, who may have been favoured with entire and unworn fossil vertebræ with the main features and proportions of the *Plesiosaurus planus*, will make allowance for the circumstances in which the materials for reconstructing that species first came to hand.

What may be more certainly predicated of the costal surface is the absence of depth and of linear horizontal bisection, both which characters are present in the cervicals of some other *Plesiosaurs*. The distance between the costal and neurapophysial surfaces is nearly three times that of the vertical diameter of the former, and the intervening non-articular surface is smooth, and also plane or flat, sloping upward towards the neurapophysial border, and showing no sinking or concavity in the longitudinal direction. The neural surface, $2\frac{1}{2}$ lines in breadth at the narrowest part, slightly expands towards the posterior surface of the centrum. The neurapophysial surfaces are coextensive with the long or fore-and-aft diameter of the centrum, and of nearly equal breadth anteriorly ; they are smooth and very shallow, with a slightly defined, thin border, which is undulated outwardly, descend-

ing lower upon the fore than upon the hind half of the centrum, and giving, in the pair, a contour somewhat like that of a saddle; I do not, however, insist upon this as a constant character of the cervicals of this species. In the present vertebra one of the venous orifices is larger than the other; but in a second, of similar size and contiguous position, they show the usual equality. The flatness of the terminal surfaces is remarkable, and betokens restriction of the movements of the neck of the species. On the similarly flattened under surface the venous foramina (fig. 4, *v*) open nearer the anterior than the posterior border.

In a cervical vertebra, of similar size and proportions, the neurapophysial surfaces are more concave in the longitudinal direction. As the cervical series approach the back the centrams increase in length, while preserving about the same relative breadth. In the vertebra, figs. 5—7, the costal surface (*pl*) has risen to the neurapophysial one (*np*), with which it has become confluent; the inferior tract of the centrum now describes a convexity between the two costal surfaces, though it is but slight; the contour of the terminal surface accordingly presents the form of a transversely elongate ellipse (fig. 6). The fore-and-aft contour of the under surface is very slightly concave, almost flat. The posterior border of the costal surface is produced, forming the beginning of a parapophysis (fig. 7). The neurapophysial surfaces are slightly excavated, with a defined but hardly raised border; they are undulated, smooth, with scattered foramina; their breadth is now one third more than their length. In the posterior cervical (fig. 7) the venous canals on the neural surface show the same inequality as in fig. 3.

In the vertebra in which the costal surface has wholly passed upon the neurapophysis (fig. 10, *np*), and which, from the proportions of length to breadth, is to be reckoned as coming from the beginning of the dorsal series, the sides of the centrum are excavated under the neurapophysial surfaces; but below the excavation, which is not deep, the longitudinal contour is as nearly straight as in the antecedent vertebra.

To one of the terminal surfaces of this vertebra (fig. 11) adheres the remnant of the lower valve of the spondyloid shell—*Dianchora striata*: the living *Spondylus Gussoni*, which most resembles the characteristic Green-sand bivalve, dwells at great depths in coral-beds of the Mediterranean. We may conceive, by analogy, that the carcass of the dead Plesiosaur, sinking and decomposing in a similar chalky manufactory, left its scattered bones to serve as the resting-places of those bivalves of its locality and period which, like the modern smooth and spiny oysters, anchor themselves for life after a brief locomotive period.

Towards the middle region of the back the centrams gain in vertical diameter, and somewhat in length, with a diminution of their transverse diameter. The concavity of the non-articular surface from before backward is still greatest near the neurapophysis, but has less the aspect of a circumscribed depression than in

the anterior vertebra. The neurapophysial pits now diminish in breadth, preserving their length nearly coequal with that of the centrum itself. The terminal articular surfaces show a slight sinuosity, feebly concave, with a less convexity at the middle part. The under surface still retains an aspect of flatness, both from before backward and from side to side. Most of these mid-dorsal vertebræ show a slight difference of length in the two sides, as in figs. 9 and 14.

In one dorsal vertebra (fig. 26) a terminal articular surface, showing a porous or spongy character, is also marked by irregular grooves converging toward the centre, like the corresponding surface of a Cetaceous vertebra from which the epiphysial plate had become attached. Save in this single instance, I never met with such an appearance in a Plesiosaurian vertebra; the opposite surface is smooth, as are both surfaces in the other vertebræ of *Pl. planus*.

In the tail the broad and short proportions of the vertebral centrum are resumed (figs. 16—19), but with a more marked concavity of the terminal articular surfaces, which in one vertebra showed fine lines radiating from the centre. A broad, but almost flattened, border extends from the terminal surface upon the side of the centrum, joining the costal surface, and expanding to mark the place and extent of attachment of the hæmapophyses. The diminished size and feebler impression of the neurapophyses bespeak the reduction of the neural arch at this part of the vertebral column. The pleurapophyses retain their independency, and were articulated to a small subcircular surface on the upper half of the side of the centrum; the lower half is almost flat, and joins, at an open angle, the equally flat, broad under surface, which is bordered, like the sides, by the deflected tract from the articular ends. The venous canals open upon the middle of the under surface, about four lines apart.

A few small vertebral centruns belonging to the present series, and apparently from a similar-sized Plesiosaur, if not part of the same individual, seem to be reduced to the simplicity of supporting only neurapophyses, and show no distinct marks of articulations for either pleur- or hæm- apophyses. The centruns are broad, depressed, with perfectly flat terminal surfaces, and a flattened under surface. They may come from the beginning of the neck, or from the end of the tail. I reject the latter notion, because the analogy of the terminal caudal vertebræ, or those in which the hæmapophyses ceased to exist, in other *Plesiosaurs*, would lead one to expect a concavity of the articular surfaces, and a diminution in the lateral rather than in the vertical direction, a compressed rather than a depressed form. Assuming, then, that these vertebræ are from the beginning of the neck, the question next arises whether pleurapophyses were wholly absent, or whether they were so small and so feebly articulated as to leave no sign of their attachment, at least after the degree, slight as it is, of superficial abrasion to which the fossils have been subject. I think the latter condition may be the more

probable one, although in some species of *Plesiosaurus*, as *e.g.* the present, the "hatchet bones" or cervical ribs might only commence on the third or fourth vertebra, beyond the coalesced atlas and axis. As a general rule, they begin on the second cervical.

Thus, the characters of the *Plesiosaurus planus* are exemplified, so far as they are shown by the vertebral centres, from all the chief regions or parts of that column. The majority of the vertebræ which have served for the comparisons and illustrations leading to the above-given information as to the species, have been kindly confided to me for that purpose by the Rev. Adam Sedgwick, F.R.S., Woodwardian Professor in the University of Cambridge.

These vertebræ differ from those of all the previously described species of Cretaceous Plesiosaurs in the proportions of breadth to length, especially in the cervical region, and in the flatness of the terminal articular and of some other surfaces of the centrum.

Several larger vertebræ have reached me singly, as though from a more scattered disposition of parts of the dislocated skeleton in the phosphatic Greensand bed of Cambridgeshire, which agree in character with the *Plesiosaurus planus*.

In the *Plesiosaurus pachyomus* the centrum increases in breadth as it approaches the back, whilst some of the dorsal vertebræ offer almost the same proportions as those in the above-described series.

But the difference in the corresponding cervical vertebræ is very striking, as is exemplified in the following comparative admeasurements.

Admeasurements of vertebral centrum:—

	Anterior cervical.		Middle cervical.	
	<i>Pl. pachyomus.</i>	<i>Pl. planus.</i>	<i>Pl. pachyomus.</i>	<i>Pl. planus.</i>
	In. lines.	In. lines.	In. lines.	In. lines.
Antero-posterior diameter or length .	1 9 .	0 11 .	2 0 .	1 3 .
Transverse diameter or breadth .	2 3 .	1 10 .	2 3 .	1 5 .
Vertical diameter or height .	1 9 .	1 1 .	2 3 .	1 3 .

The centrum (Tab. II, figs. 1 and 2) is of a vertebra from the posterior part of the neck. The anterior articular surface presents a transversely elongate elliptical form (fig. 1), contrasting with the almost circular contour of the same part in *Plesiosaurus pachyomus* (Monogr. 1851, Tab. XX, fig. 2). It is very slightly, but uniformly, concave. The neurapophysial pits (fig. 2, *np*), of a triangular form, and coextensive with the fore-and-aft extent of the centrum, are divided by a neural canal (fig. 2, *n*), of about 4 lines in breadth, and their lower angle, which is rounded off, projects from the side of the centrum, which is not the case in *Plesiosaurus pachyomus*. The costal pit (Tab. I, fig. 1, *pl*) is much smaller than in *Plesiosaurus*

pachyomus (l. c., Tab. XX, fig. 1, *pl*). The under surface of the centrum is flat from before backward, and describes a gentle uniform convexity from one costal pit to the other.

The vertebral centrum, Tab. II, figs. 3, 4, 5, is from the base of the neck, and from a larger individual. The bases of the neurapophysial pits (fig. 4, *np*) have not been coextended with the increased length of the centrum, and the apex contracts more quickly, and is extended to the upper division of the costal pit. The breadth of the neural surface (ib., *n*) is the same as in the more anterior cervical centrum (fig. 2); but the orifices of the venous canals are more conspicuous. Only a small part of the costal pit (ib., *pl*) now marks the centrum; it projects from the side of that element, nearer its posterior surface. The articular surfaces of the centrum (ib., fig. 3, *c*) are nearly flat, and slightly undulating, without a central pit. The lower orifices of the venous canal are about two lines apart.

The centrum, Tab. II, figs. 6—9, is from the base of the neck of another and larger individual of the *Plesiosaurus planus*, and, with a moderate increase of all its dimensions, shows least that of breadth. The articular surface of the centrum (fig. 6, *c*) has a shallow depression at its middle part, occupying about half the breadth of the surface; it is flat at the circumference, and its margin, though obtuse, is narrow and well defined. The narrow outer part of the neurapophysial tract (ib., fig. 9, *np*) has a well-defined raised border, terminating in the major part of the costal surface, the lower half of which is much reduced in size; the interspace is occupied by a small mass of matrix. The under surface shows a slight concavity from before backward. The non-articular surface of the centrum is almost smooth.

A similar and closely succeeding vertebral centrum of the same species of *Plesiosaurus* is figured in Tab. III, figs. 5 and 6. It is more mutilated, and a portion of a rib is cemented to the neural surface (fig. 6). The costal surface has risen wholly upon the neurapophysis (*np*), the base of which adheres to the centrum, and projects outward as a costal diapophysis (*d*). This centrum is from the fore part of the dorsal region.

The cervical centrum (Tab. III, figs. 1—4) appears to have come from the basal third of the neck, perhaps from the beginning of that part, in which the contour of the articular surface, expanding towards the lower part, takes on, as in the antecedent cervicals (Tab. I, fig. 2), something of a triangular form; here, however, the shape of the neurapophysial surfaces (*np*) is of a more regular triangular form (compared with fig. 2, Tab. II) and they are connected by a narrow, slightly elevated tract with the costal pit (*pl*). This articular surface begins to diminish in antero-posterior extent, indicating a corresponding change in the shape of the shaft of the costal rib; the terminal articular surface of the centrum has a slight central

depression, of the same relative extent as in fig. 6, Tab. II. The under surface (Tab. III, fig. 4) is almost flat, both lengthwise and transversely; the venous outlets present the same relative position, and the non-articular surface of the centrum shows the same degree of smoothness and flatness as in the smaller vertebræ (Tab. I, figs. 2, 6). The present centrum belongs to the same species of *Plesiosaurus* as those of the more regular elliptical form, and is merely indicative of a different position in the region of the neck.

A centrum with the surface much abraded (Tab. III, fig. 8) appears to have presented the same inferior expansion, and consequent triangular form, as fig. 1; but in the under surface (fig. 9) the venous canals have opened into well-marked depressions. Other differences, as in the character of the neurapophysial surfaces (fig. 7, *np*), may be due to the degree of abrasion to which the present fossil has been subject.

PLESIOSAURUS BERNARDI, Owen. Cervical Vertebræ. Tab. IV.

In my 'Monograph of the Fossil Reptilia of the Cretaceous Formations,' Volume of the Palæontographical Society for 1851, p. 60, I characterised a species of *Plesiosaurus* from a cervical vertebra then in the museum of my esteemed friend, FREDERIC DIXON, Esq., of Worthing, under the name of *Plesiosaurus Bernardi*, which vertebra was figured in Plate XVIII of the above-cited Monograph. I have subsequently had the opportunity of examining several other vertebræ of a *Plesiosaurus* from the Green-sand of Reach, near Cambridge, which are referable to the same species, but most of them to an individual of smaller size, and probably of immature age.

The specimen (Tab. IV, figs. 1, 2, 3, 4) is an anterior cervical vertebra, which agrees with the more posterior one above figured in the degree of concavity of the articular surfaces of the centrum, in the extent of the peripheral border of that cavity, which is convexly bevelled off ("évasé"), and in the relative position of the neur- and pleur-apophyses; the breadth of the centrum is not so much greater proportionally to the length; but this difference I believe to be due to the more anterior position in the vertebral series from which the present specimen has been derived.

The neurapophysial depression (*np*) is deep and smooth, encroaching further on the convex border of the centrum at its back than at its fore part; they are divided at the upper surface of the centrum by a neural tract (fig. 3, *n*), about 2 lines broad at its narrowest part. The non-articular surface of the centrum is moderately smooth, especially at the sides between the neur- (*np*) and pleur- (*pl*)

apophysial pits, (fig. 1) ; its vertical extent here is not quite equal to that of the pleurapophysial pit. This is of an oblong oval shape, less deeply concave than the neurapophysial pit, with a smooth surface, nearer the posterior than the anterior surface of the vertebra, with the border slightly prominent (fig. 4, *pl*). The venous foramina at the lower surface (fig. 4) are situated in depressions, divided by a ridge-like narrow tract of the centrum. In this character, but more especially in the depth of the terminal articular surfaces, with their broad and thick convex border, and in the position of the riblet, the present centrum is referable to the *Plesiosaurus Bernardi*.

The following are dimensions of this cervical centrum :

		<i>Pl. Bernardi.</i>
		In. lines.
Antero-posterior diameter or length	. . . . .	1 2
Transverse diameter or breadth	. . . . .	1 4
Vertical diameter or height	. . . . .	1 4

The centrum, Tab. IV, figs. 5 and 6, appears to have succeeded the foregoing in the same cervical series, with, perhaps, the intervention of one or two vertebræ. It is similar in colour and mineral character, and from the same locality. It repeats the distinctive characters of *Plesiosaurus Bernardi*. It indicates by a slight obliquity the effects of posthumous pressure.

This mechanical force has distorted in a greater degree a centrum (Tab. IV, figs. 7 and 8), doubtless from a more posterior part of the same neck. The margins of the pleurapophysial pits are here rather more produced. The middle of the deep concavity of the terminal surfaces is impressed by a transverse pit or linear mark (fig. 8).

Col. Kiprianoff, of the Imperial Russian Engineer Corps, submitted to me some plesiosaurian vertebræ from the Neocomian deposits, or Green-sand, of Kursk, in the district of Kursk, near Moscow, which offered all the characters of the *Plesiosaurus Bernardi*. A cervical vertebra, intermediate in size between figs. 6 and 7, shows a partial anchylosis to the centrum of both neur- and pleur- apophyses. The riblet was confluent to a surface near the lower part of the centrum, about the same distance from the neurapophysis as in the first-described vertebra (fig. 1) from the Cambridge Green-sand. The under surface was ridged or pinched up, as it were, between the venous foramina, each of which was also situated in a depression between the median ridge and the base of the riblet. This element expanded, and its posterior angle was produced backward. The following were the dimensions of the centrum of this vertebra :

		<i>Plesiosaurus Bernardi.</i>	
		In. lines.	
Antero-posterior diameter or length	. . . . .	1	3
Transverse diameter or breadth	. . . . .	1	7
Vertical diameter or height	. . . . .	1	4

In a more posterior cervical vertebra, from the same Russian locality, the terminal articular surfaces are deeper towards the centre, with the out-turned or "évasé" borders very thick. The base of the neurapophysis was here also partially anchylosed, and the rib more completely so; it presented a rhomboid form, being inclined backward as well as outward, with the anterior angle rounded, and the posterior one produced. The inferior medial ridge was well marked. The breadth of the centrum was relatively greater than in the preceding vertebra.

In the vertebræ from the Cambridge Green-sand (Tab. IV, figs. 9 and 10), which have succeeded one another from about the same part of the neck, anchylosis of the pleurapophysis has not been completed; but that of the neurapophysis (*np*) has been so to a degree sufficient for preserving their base in connection with the centrum, although the summit has undergone fracture. The line of suture is, however, very distinct.

The terminal surface of the centrum presents the same degree of concavity, with a slight central horizontal linear depression, Tab. V, fig. 1, as shown in Tab. IV, fig. 8. The base of the neurapophysis (*np*) extends to the anterior margin of the centrum, but not quite to the posterior one. The outer surface of the neurapophysis presents a low obtuse ridge or rising, extending from near the infero-posterior angle to the outer side of the prezygapophysis (Tab. IV, figs. 9, 10, 11, *z*); the aspect of the articular surface of this process is obliquely upward and inward. The posterior border of the neurapophysis is thicker, or more obtuse, than the anterior one; the internal surface is smooth and even. Rather less than the vertical diameter of the pleurapophysial pit (figs. 10 and 11, *pl*) intervenes between it and the base of the neurapophysis (*np*). The inferior surface of the centrum presents the ridge between the two depressions into which the venous vertical canals open.

In the vertebra (Tab. IV, fig. 11), from a more posterior part of the neck, or from a larger *Plesiosaurus*, a greater proportion of the neural arch (*np*) is preserved, partially anchylosed to the centrum; the sides are strengthened by the same oblique thickening, extending to the prezygapophysis (*z*); this is larger than the postzygapophysis (*z'*), and the breadth of the arch across the prezygapophyses is nearly twice that across the posterior pair (Tab. V, fig. 6). The neural spine appears to have been a thin plate; its base (Tab. V, fig. 6) extends from the notch between the postzygapophyses (*z'*) to within 3 lines of that between the prezygapophyses (*z*). This vertebra has been compressed laterally, and rather obliquely, by posthumous pressure; yet under such general support that the neural arch,

though apparently narrowed from side to side is not broken; the neural canal (Tab. V, fig. 2, *n*) presents a vertical diameter of 11 lines, and a transverse diameter of 7 lines. The costal depression (Tab. IV, fig. 11, *pl*) extends nearer to the posterior than to the anterior surface of the centrum. The articular surfaces of the centrum show the characteristic depth of the concavity, but with relatively less thick obtuse borders, Tab. V, fig. 2.

The dimensions of this vertebra are :

	In. lines.
Length of centrum	1 7
Height of ditto	2 0
Breadth of hinder surface of ditto	1 11
From base of neurapophysis to end of postzygapophysis	2 3
From end of pre- to that of postzygapophyses	2 3
Breadth of neural arch across prezygapophyses	2 0
" " " " " postzygapophyses	1 1
Antero-posterior extent of base of neural spine	1 4

The vertebra, Tab. V, figs. 3, 4, and 5, appears to have come from the middle of the neck of an older and larger *Plesiosaurus*, and it displays, in a striking degree, the characteristics of that part of the *Plesiosaurus Bernardi*.

The depth of the concavity of the terminal surfaces of the centrum is almost ichthyosaurian; the breadth of the convex border of each cavity is extreme, and is equally divided between the smoother articular surface continuous with that of the concavity, and the surface roughened by fine concentric linear impressions, forming the outer part of the border, and indicative of the strong circular ligaments which tied the vertebræ together.

Anchylosis of both neur- and pleur-apophyses is here complete; and the missing parts of both vertebral elements have been broken off. The neurapophysial suture is, however, traceable; and the characteristic distance between it and the cervical rib is thus exemplified. The rising between the vascular depressions on the under part of the centrum (fig. 4) is broader and less ridge-like than in the more advanced vertebræ of the neck. In this vertebra, in relation to its more posterior position in the neck, the transverse diameter has increased upon the longitudinal one, as is shown in the following admeasurements :

	In. lines.
Length of centrum	1 9
Breadth of ditto, posterior surface	2 6

The riblet, at its fractured surface (fig. 5, *pl*), shows an antero-posterior diameter of 10 lines, a vertical diameter of 5 lines.

Valves of the fry, or young, of a species of *Plicatula* (?) adhere to this fossil, to which they attached themselves at the period when the cretaceous beds,

receiving the carcasses of the dead *Plesiosaurs*, were still in process of formation, where now the dry land of Cambridgeshire has risen.

In a dorsal vertebra of this species, from the Neocomian deposits of Kursk, the terminal articular surfaces of the centrum were less concave than in the neck, and the lower surface was obscurely or very obtusely ridged. This vertebra measured in:—

	In. lines.
Length	1 9
Breadth, anterior surface of centrum	2 6
„ posterior surface of centrum	2 8

A caudal vertebra of the same species of *Plesiosaurus*, from the same formation and locality, showed the hæmapophysial surface best marked on the posterior border of the centrum; they were each subtriangular in shape, 6 lines in long diameter, and 1 inch apart. The pleurapophyses were anchylosed to the upper part of the centrum, or over the base of the neurapophysis; but the sutural line of juncture could be traced. The terminal surfaces of the centrum were moderately and gradually concave, but with the broad obtuse border. The lower surface was nearly flat and subquadrate, with only a feeble indication of a rising between two small venous foramina. The length of this vertebra was 1 inch 7 lines, the breadth of the centrum was 2 inches 3 lines.

I have introduced the above notices of the vertebræ of the *Plesiosaurus Bernardi* from the Green-sand beds of the neighbourhood of Moscow, in illustration of the geographical range of the species at the period of geological time in which it existed; this period extending from the “neocomian” to the “upper chalk” of the Cretaceous series. In the following section will be found a similar illustration of the geographical range of another Cretaceous Plesiosaur.

PLESIOSAURUS NEOCOMIENSIS, Campiche. *Cervical and dorsal vertebræ; humerus and femur.* Plate VI.

Professor Pictet and Dr. Campiche, in their excellent ‘Description des Fossiles du Terrain Crétacé des Environs de Sainte-Croix,’ 4to, 1858—1860, have described and figured three centrams of a dorsal vertebra of a *Plesiosaurus*, to which Dr. Campiche has attached the name *neocomiensis*, inasmuch as these fossils were derived from the lower neocomian or “valanginian” beds of the Cretaceous deposits described in the above work. And this name, although there be other neocomian Plesiosaurs, and there may be many, I retain for a species, richly illustrated, from the Upper Green-sand deposits of Cambridgeshire, and which I believe to be identical with Dr. Campiche’s.

Dorsal centrams are usually the least significant of specific characters, owing to the limitation of the articular surfaces to the neurapophysial and terminal ones, and also owing to a resumption, more or less, in the dorsal region of the more common proportions of the centrum, when this is departed from, either in excess of breadth, depth, or shortness, in the cervical region.

Dr. Campiche's description is so minute and exact that the correspondence of the dorsal centrum (Tab. VI, figs. 9, 10, 11) with the characters expressed at p. 43, op. cit., and shown in "Plate VI" of that work, will be found to justify the specific approximation. The centrum of *Pl. neocomiensis* is "a little broader than high, so that the articular surfaces form nearly a transverse, very slightly elongated, ellipse; the shape would be even better expressed by a circle, of which the upper part was flattened and subtruncate (see fig. 18)."* "The length is sensibly inferior to the two other dimensions; the sides are strongly and gradually excavated, so that when the vertebra is viewed from above," (as in fig. 11, Tab. VI) op. cit., "its middle part is much narrower than its articular surfaces. The inferior region, corresponding to the medial line of the body, is more feebly excavated.† The two large and deep neurapophysial pits are slightly arched inwardly, and are two and a half times as long as they are large; but the most significant character is the slight concavity of the terminal surfaces, with their middle part feebly raised into an irregular protuberance."

In the larger of the dorsal centrams from the Swiss Neocomian, measuring 2 inches 7 lines in transverse diameter, the median rising is 10 lines in diameter, but not more prominent than the more circumscribed rising in Tab. VI, fig. 10 of the present Monograph. In the smaller Swiss centrum (Plate VI, fig. 2 of op. cit.) the central eminence is broader and lower than in the nearly equal-sized centrum (Tab. VI, fig. 10) of the present Monograph; nevertheless, I am inclined to think that the mamillate character of the terminal articular surfaces shown in the cervical vertebræ may, like other characteristic modifications, be less strongly manifested in the dorsal vertebræ, or in some of the dorsal vertebræ of the same individual; and, therefore, I supersede my MS. denomination of *Plesiosaurus mamillatus*, under which I distinguished those vertebræ from the Cambridge Green-sand, when first obtained

* "Un peu plus larges qu'ils ne sont hauts, en sorte, que leurs faces articulaires forment, à peu près, une ellipse transverse très peu allongée. Leur forme serait même mieux exprimée par un cercle dont la partie supérieure serait aplatie et subtronquée."—Op. cit., p. 43.

† "La longueur est sensiblement inférieure aux deux autres dimensions. Les flancs sont fortement et graduellement excavés, en sorte que, lorsqu'on regarde la vertèbre au dessus, sa partie médiane est beaucoup plus étroite que les faces articulaires." "La région inférieure qui correspond à la ligne médiane des corps est beaucoup plus faiblement infléchée. A la face supérieure, on voit deux grandes et profondes impressions, correspondant à l'insertion des neurapophyses ou lames tectrices. Elles sont un peu arquées en dedans, deux fois et demie aussi longues que larges, les faces articulaires sont légèrement concaves, avec leur milieu faiblement relevé en une protubérance irrégulière."—Op. cit., p. 43.

for the British Museum, and adopt Mr. Campiche's name, which has the priority of publication, under the conviction of the specific identity of the vertebræ from the two localities.

All the mamillate vertebræ I have yet seen from the Cambridge Green-sand indicate a *Plesiosaurus* not larger than that represented by the smallest of the dorsal centrons from St. Croix.

The cervical vertebræ (Tab. VI, figs. 1—4) shows a greater proportional transverse dimension of the centrum than in the vertebra from the dorsal region (ib., figs. 9, 10), the sides of the centrum are less concave (compare fig. 4 with fig. 11); on the inferior surface the shallow impressions into which the vertical venous canals open, are divided by a narrow ridge-like tract (ib., fig. 4). The neurapophysial depressions (figs. 1 and 3, *np*) are broader than in the dorsal centrum, are of a triangular form, and, as the intervening neural tract is of equal breadth (ib., fig. 3), it is relatively larger than in the dorsal vertebra (ib., fig. 11); the venous foramina in this tract (fig. 3, *n*) are also wider apart. The costal surface (fig. 1, *pl*) is large in proportion to the centrum, well defined, but not deep; transversely elliptic; 9 lines in longitudinal by 6 lines in vertical diameter, and 3 lines distant from the apex of the neurapophysial pit (*np*): it is situated rather nearer the posterior than the anterior part of the centrum, and its margin slightly projects from the level of the non-articular surface of the centrum; the distance between the inferior borders of the two costal pits (fig. 4, *pl*) is 10 lines. The terminal articular surface (fig. 2) is less concave than in the *Plesiosaurus Bernardi*, and although obtuse and convex at the circumference, is less thick or tumid there; but the conspicuous and chief distinction is the well-defined mammillary eminence in the centre of each of the terminal concavities. The following are dimensions of this centrum:

	In. lines.
Length	1 1
Breadth	1 5
Depth	1 4

Figures 5 and 6 represent a vertebra of apparently the same individual from the base of the neck, where the costal surface (Tab. VI, fig. 5, *pl*) has almost wholly ascended from the centrum upon the neurapophysis (*np*), and is more prominent than in the average cervical vertebræ. The under surface of the vertebra is not excavated or ridged, and is very slightly concave lengthwise; it resembles that of the average dorsal vertebræ. The mamillate character of the terminal articular surface is as well marked as in the average cervical vertebræ.

Figures 7 and 8 are of a posterior cervical vertebra of another individual, from a different locality, in which the centrum is relatively shorter than in the two fore-

going vertebræ; in other respects the characters closely accord with those of the posterior cervical centrum (figs. 5 and 6), and I regard the present as indicating a mere variety in the proportions of the centrum, which is also less than it appears in the plate, on account of the abrasion of the circumference of one of the terminal articular surfaces.

The dimensions of the restored centrum are:

	In. lines.
Length	1 3
Breadth of posterior surface	1 8
Height	1 6

The dorsal centrum (figs. 9, 10, 11) exhibits the characters already specified in the comparison of it with the type-vertebra of Dr. Campiche's species; the chief or sole difference is the more circumscribed and smaller circumference of the central mamilla of the terminal articular surface; the neurapophysial pits have undergone the change of form and proportions which brings them to the same pattern as in the dorsal vertebræ figured in the 'Paléontologie Suisse,' loc. cit.

In the locality whence the specimens (figs. 1—6, 9—11, Tab. VI) were exhumed, some portions of limb-bones were obtained of a *Plesiosaurus* of corresponding size, of which I select for figuring a left femur (fig. 12) and the lower two thirds of a left humerus (fig. 13). The outline of a section through the broadest part of the distal end of the humerus is given to the left of fig. 13, to exemplify the difference in the proportions of this bone from the humerus of the *Plesiosaurus pachyomus* from deposits of the same age. The outline connected by dots with fig. 12 represents a section of the proximal end of that femur. I think it most probable that both these bones appertain to the *Plesiosaurus neocomiensis* of Campiche.

PLESIOSAURUS LATISPINUS, Owen. Cervical vertebræ, Tab. VII; cervical and dorsal vertebræ, Tab. VIII; ilium and coracoid, Tab. IX.

This species was founded on the characters of the two cervical vertebræ figured in Tabs. VII and VIII. They form part of a scattered series of about a dozen vertebræ, with ribs, scapulæ, portions of the coracoid bones (Tab. IX, fig. 2), an ilium (Tab. IX, fig. 1), and a few other parts of the skeleton, included in a rock of the "Shanklin-sand" or Lower Green-sand series, from the so-called "Iguanodon Quarry," at Maidstone, Kent, where they were observed and partially wrought out

by the proprietor, WILLIAM HARDING BENSTED, Esq., to whom the earlier discovery of remains of an *Iguanodon* in the same locality and formation, is due.*

My first knowledge of these remains was obtained from plaster casts of the two most complete vertebræ which were transmitted to me by Mr. Bensted for determination of the species in 1853, which casts were afterwards presented by Mr. Bensted to the Museum of the Royal College of Surgeons.† The original of these casts, with the other portions of the skeleton discovered by Mr. Bensted, have since been purchased by the Trustees of the British Museum.

From the *Plesiosaurus pachyomus*, Owen, of the Upper Green-sand of Cambridge-shire, the present species differs in the greater relative length and breadth of the centrum in proportion to its height, in the smaller relative size of the costal surface, its greater prominence, and inferior position upon the side of the centrum, where it is supported by a low parapophysis (compare Tab. VII with Tab. XX, tom. cit., Monogr. Cretaceous Reptiles). In that plate are represented the centrum of three cervical vertebræ of the *Plesiosaurus pachyomus*; one (fig. 1) giving the characters of the ordinary or more numerous cervicals; a second (fig. 2) showing the commencement of the rise of the costal surface, and the development of the vertical ridge connecting it with the neurapophysial surface; a third (fig. 3) showing the junction of the two articular surfaces indicative of the passage of part of the head of the pleurapophysis upon the base of the neurapophysis.

The following are dimensions of an ordinary cervical centrum of the two species :

	<i>Plesiosaurus latispinus</i>	<i>Plesiosaurus pachyomus</i> .
	In. lines.	In. lines.
Length	2 8	1 11
Breadth	3 0	2 3
Height	2 6	2 3
Fore-and-aft diameter of the costal surface	1 0	1 4

The borders of the terminal articular surface are thinner and more defined in *Plesiosaurus latispinus* than in *Plesiosaurus pachyomus*. The costal surface (Tab. VII, fig. 1, *pl*) is longitudinally coextensive, in *Plesiosaurus latispinus*, with little more than one third of the fore-and-aft extent of the centrum. In *Plesiosaurus pachyomus* it is coextensive with two thirds of the same extent. In *Plesiosaurus latispinus* it is situated so low down as, in a direct side view, to mask part of the inferior contour of the centrum. In *Plesiosaurus pachyomus* it allows the whole of the lower contour to be seen in the same side view. In *Plesiosaurus latispinus* more than the vertical diameter of the costal surface, by one fifth or one sixth, intervenes between it

* See 'Monograph on the Fossil Reptilia of the Cretaceous Formations,' volume of the Palæontographical Society for 1851, p. 105.

† See 'Descriptive Catalogue of the Fossil Reptilia and Pisces,' 4to, p. 63, No. 251.

and the neurapophysial surface. The terminal articular surface (ib., fig. 3) is very little concave, sububundulating, with a transversely elliptical, very shallow, central depression. The sides of the centrum are slightly concave, the under surface more feebly so, and it is not longitudinally ridged. The venous foramina are divided by a transversely convex tract of 6 lines extent (Tab. VII, fig. 2). The whole of the non-articular surface is smooth. The costal surfaces (fig. 1, *pl*) are almost wholly situated in the posterior half of the centrum. The neural arch and spine, by rare fortune, are preserved in the present instance (fig. 1) in natural articulation with the centrum. The sutural line describes a subangular convexity downwards, and with the lowest part (*np*) nearer the anterior surface of the centrum. The neurapophysis, as it rises, has its fore-and-aft extent decreased by emarginations, of which the posterior one is the longest; this extent then increases by the development of the zygapophyses, of which the posterior (*z'*) is most raised; but the anterior (*z*) most produced. The spinous process (*ns*) is remarkable for its antero-posterior extent, preserving the same width to its truncated summit; it thus presents a subquadrate figure, and is inclined rather forward; it arises from the entire fore-and-aft extent of the median line of the neural arch. The total height of the vertebra, from the under part of the centrum to the summit of the spine, is 9 inches; the height of the spine itself is $4\frac{1}{2}$ inches; the antero-posterior diameter is $2\frac{1}{2}$ inches. The articular surfaces of the prezygapophyses (*z'*) look upward and a little inward; those of the postzygapophyses (*z*) look in the opposite direction.

Two other cervical vertebræ, with the characters above defined, are preserved in the slabs of stone exhibiting the parts of the skeleton of the same individual Plesiosaur. In the last cervical vertebra (Tab. VIII, figs. 1 and 2) the costal surface is of large size, especially in the vertical direction, and is supported in its lower third upon a parapophysis (*p*), which has now risen to the middle of the side of the centrum, and has come in contact with a diapophysial development (*d*) of the side of the neural arch, supporting the upper two thirds of the costal surface. Together they form a thick and deep outstanding process, 2 inches in vertical by 1 inch 3 lines in transverse extent, with the articular surface for the expanded head of the rib looking outward and rather downward, fig. 2. The terminal articular surface of the centrum (fig. 2, *c*) presents a sharper or better defined border than that of the normal cervical vertebra (Tab. VII, fig. 3); it is 3 inches 6 lines in transverse, and 2 inches 8 lines in vertical diameter, almost an ellipse in figure, but with the lower curve greater or deeper than the upper one; the central shallow depression is continued in the present vertebra, of similar proportions and contour as in the foregoing normal cervical vertebra. The neural arch has become ankylosed to the centrum, but the greater part is broken away. The neural canal (*n*) is subcircular, 8 lines in diameter.

In the dorsal region, where the rib is supported wholly by a diapophysis developed from the platform of the neural arch (*np*), the centrum has assumed the ordinary subcircular shape, at least at its articular ends (Tab. VIII, fig. 3). The surface is very slightly and uniformly concave in most, with a slight central depression occupying about one third of the vertical diameter of the surface; but in some, as in fig. 3, there is hardly any trace of the median depression. The sides of the centrum are rather more concave lengthwise than in the cervical series, but least so at the lower part.

The following are dimensions of the dorsal vertebra:

		<i>Plesiosaurus latissimus.</i>	
		In.	lines.
Length of centrum	. . . . .	2	6
Breadth of ditto, at articular end	. . . . .	2	11
Breadth of ditto, at the middle	. . . . .	2	4
Height of ditto, at articular end	. . . . .	2	10
Vertical diameter of outlet of neural canal	. . . . .	0	10

The following are admeasurements of a dorsal vertebra, having a greater proportion of the neural arch preserved:

		In.	lines.
Length of centrum . . . . .	. . . . .	2	8
Depth of terminal surface . . . . .	. . . . .	2	10
Breadth of ditto . . . . .	. . . . .	3	
Breadth of the middle of the centrum . . . . .	. . . . .	2	5
From the under part of the centrum to the upper part of the diapophysis . . . . .	. . . . .	4	3
From ditto to summit of neural spine . . . . .	. . . . .	8	0
Fore-and-aft extent of neural spine . . . . .	. . . . .	2	3

The chief changes observed in the middle dorsal vertebræ are the almost circular contour of the articular ends of the centrum, and the minor antero-posterior breadth of the neural spine.

Of one of the dorsal ribs an extent of fourteen inches in length is preserved; it shows two flexures; the first and shortest is concave upward, the rest convex upward and outward, for half the extent of the rib, the rest being straight. Many smaller parts of the ribs are scattered about the block of matrix.

The coracoids exhibit the proportional size, and broad expanse, characteristic of the genus; they are in too fractured and mutilated a state to serve for determination of any specific characters. One of the largest portions is figured in Tab. IX, fig. 2.

The ilium, five inches in length, and one inch in breadth at the middle, expands to both extremities by outgrowth from one and the same margin, which is thus made concave, whilst the opposite margin is nearly straight (Tab. IX, fig. 1). The upper expanded end is obliquely truncate. The lower one shows the articular facets contributed to the acetabulum, and to the other pelvic bones entering into the formations of that articular cavity.

SUPPLEMENT (No. III)

TO THE

MONOGRAPH

ON THE

I G U A N O D O N.

Mandible of a young Iguanodon (Tab. X).

I HAVE been favoured by the Rev. W. Fox, M.A., Rector of Brixton, Isle of Wight, with the inspection of a portion of the left mandibular ramus of an Iguanodon (Tab. X, figs. 1—4), including the entire series of alveoli. These are fifteen in number, and are clearly indicated by the angular risings of the outer alveolar wall, forming the intervals or divisions of the alveoli (fig. 4, 1—15). Between the summits of the angular processes the upper margin of the socket is deeply concave, and, the sockets being contiguous, a strongly marked crenate character is given to the border of the outer alveolar wall.

The longitudinal extent of the alveolar portion of the present ramus is 4 inches 3 lines. About an inch of the edentulous fore part of the ramus is preserved, but the symphysial end is broken away. At the opposite part of the fragment it has broken off, about three lines behind the last alveolus, from the rest of the jaw.

The teeth which occupied the alveolar depressions of the outer wall are gone. The germs of three successional teeth (ib., figs. 1 and 2, 6, 12, 14) are preserved. The summit of the hindmost (14) has risen to the level of the opening of the antepenultimate socket; the next in advance (12) has risen half way towards the outlet of the twelfth socket; the crown of the third just shows at the bottom of the sixth socket, counting from before backward. Each of these germ-teeth has the inner surface exposed of the summit of the crown, the anterior one showing the least proportion of the tooth. The primary longitudinal ridge (fig. 5, *a*) and the marginal serrations (*cc'*) are boldly and beautifully marked on the dark, lustrous enamel, the serrations being continued by grooves, some way upon the exposed inner side of

the crown. The primary ridge more equally divides the summit of the crown here seen than in the part below, but the greater extent of the anterior area (*c*) is appreciable; the secondary longitudinal ridge (*b*) is discernible in both the anterior and posterior areae of the crown, in the last two germs (fig. 1, 12, 14, and fig. 6). So much of the crown as appears in these teeth shows greater fore-and-aft breadth than the socket they would rise into, or rather than the socket of their predecessor, and the difference of breadth is so much greater in the basal part of the crown as to suggest much growth of the jaw in the progress of the germ to the state of a fully developed tooth in place. We thus obtain evidence of the immaturity of the specimen, and that it has not belonged to a distinct and diminutive species of *Iguanodon*.

Like all reptiles, the *Iguanodon* shed and renewed its teeth many times during the course of life; the new following the old teeth vertically, and being, therefore, in the growing animal, of a larger size than those they were about to displace. With the shedding of the deciduous teeth there was more or less absorption of their sockets, and with the rise of the successional teeth there was a concomitant formation of suitable, and, therefore, larger sockets.

In the Crocodile the number of teeth, or of sockets of one and the same set of teeth, does not vary with age, according to the observations of Cuvier.* Each tooth succeeds its forebear vertically, and none are added to the series, as in mammalia, from behind.

I believe myself able now to adduce evidence that the *Iguanodon* added this mammalian mode of succession to some other characters, which have been in previous Monographs pointed out, exemplifying its greater resemblance to the warm-blooded beasts than any existing form of reptile manifests.

The mandible of the young *Iguanodon* here described shows at the utmost fifteen sockets in the unquestionably entire series, occupying a longitudinal extent of four inches and a quarter. The mandible of the somewhat older *Iguanodon*, from the Wealden of Stammerham, Sussex, described and figured in my Monograph (1855) Tabs. X and XI, shows eighteen alveoli, occupying a longitudinal extent of six inches.

The mandible of the *Iguanodon* from the Wealden of Tilgate, Sussex, figured by Mantell in the 'Philosophical Transactions' for 1848, Pl. xvii, seems to have had at least twenty alveoli in a longitudinal extent of fourteen inches. The back part of the series is too much mutilated for precisely showing the divisions

* "Les dents offrent plusieurs remarques intéressantes dans le crocodile. La première, c'est que leur nombre ne change point avec l'âge. Le crocodile qui sort de l'œuf les a autant que celui de vingt pieds de long."—"Je me suis assuré de ce fait dans une série de huit têtes croissant en grandeur, depuis un pouce jusqu'à deux pieds." Cuvier, 'Ossements Fossiles,' 4to, tom. v, pt. ii (1825), p. 90.

of the sockets ; but the number, eighteen, which I originally estimated, from the figures of the fossil in the 'Philosophical Transactions' is clearly below the number which may be estimated in the alveolar tract of the original specimen now in the British Museum.

From the foregoing facts, therefore, it may be concluded that the Iguanodon, in the progress of growth, from the period at which the dentigerous part of each ramus of the mandible is four inches in length to that in which the same part is fourteen inches in length, acquires four or five additional teeth in each series, which from the rapidly decreasing depth of the three or four hindmost alveoli, I infer to be developed, like the true molars of mammals, in new and distinct alveoli behind those in place.

My obliging correspondent, Mr. Fox, who had been struck with the inferiority of number of the alveoli in his small specimen, compared with the indication of them in Mantell's plate of the larger jaw from Tilgate, supposed that it might indicate a distinction of species ; but the whole evidence of the Iguanodon's mandibular structure, including the intermediate-sized specimen obtained by Mr. Holmes from Stammerham, appears to me to show only difference of age, and to bring to light a new and important characteristic of the dentition of the large extinct Herbivorous Reptile.

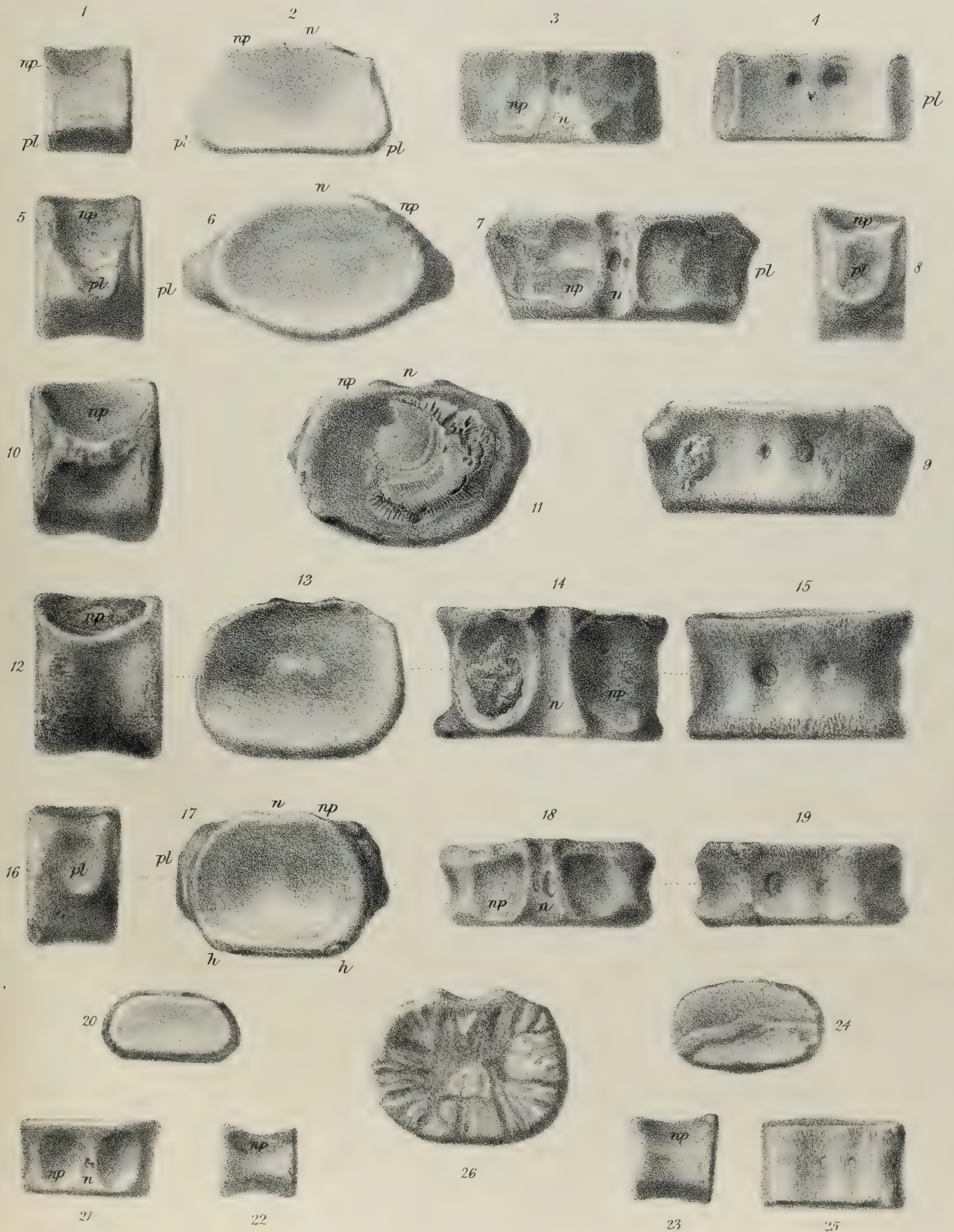
TAB. I.

Plesiosaurus planus, nat. size.

Fig.

1. Side view of centrum of an anterior cervical vertebra.
2. Front view of ditto.
3. Upper view of ditto.
4. Under view of ditto.
5. Side view of centrum of a posterior cervical vertebra.
6. Front view of ditto.
7. Upper view of ditto.
8. Side view of centrum of a posterior cervical vertebra.
9. Under view of the same centrum as fig. 7.
10. Side view of centrum of the first dorsal vertebra.
11. Front view of ditto, with portion of the lower valve of *Dianchora striata* attached.
12. Side view of centrum of a dorsal vertebra.
13. Front view of ditto.
14. Upper view of ditto.
15. Lower view of ditto.
16. Side view of centrum of anterior caudal vertebra.
17. Front view of ditto.
18. Upper view of ditto.
19. Under view of ditto.
20. Front view of centrum of third (?) cervical vertebra.
21. Upper view of ditto.
22. Side view of ditto.
23. Side view of centrum of fourth (?) cervical vertebra.
24. Front view of ditto.
25. Under view of ditto.
26. Front view of centrum of a dorsal vertebra, with grooved articular surface.

From the Upper Green-sand near Cambridge. In the Woodwardian and British Museums.



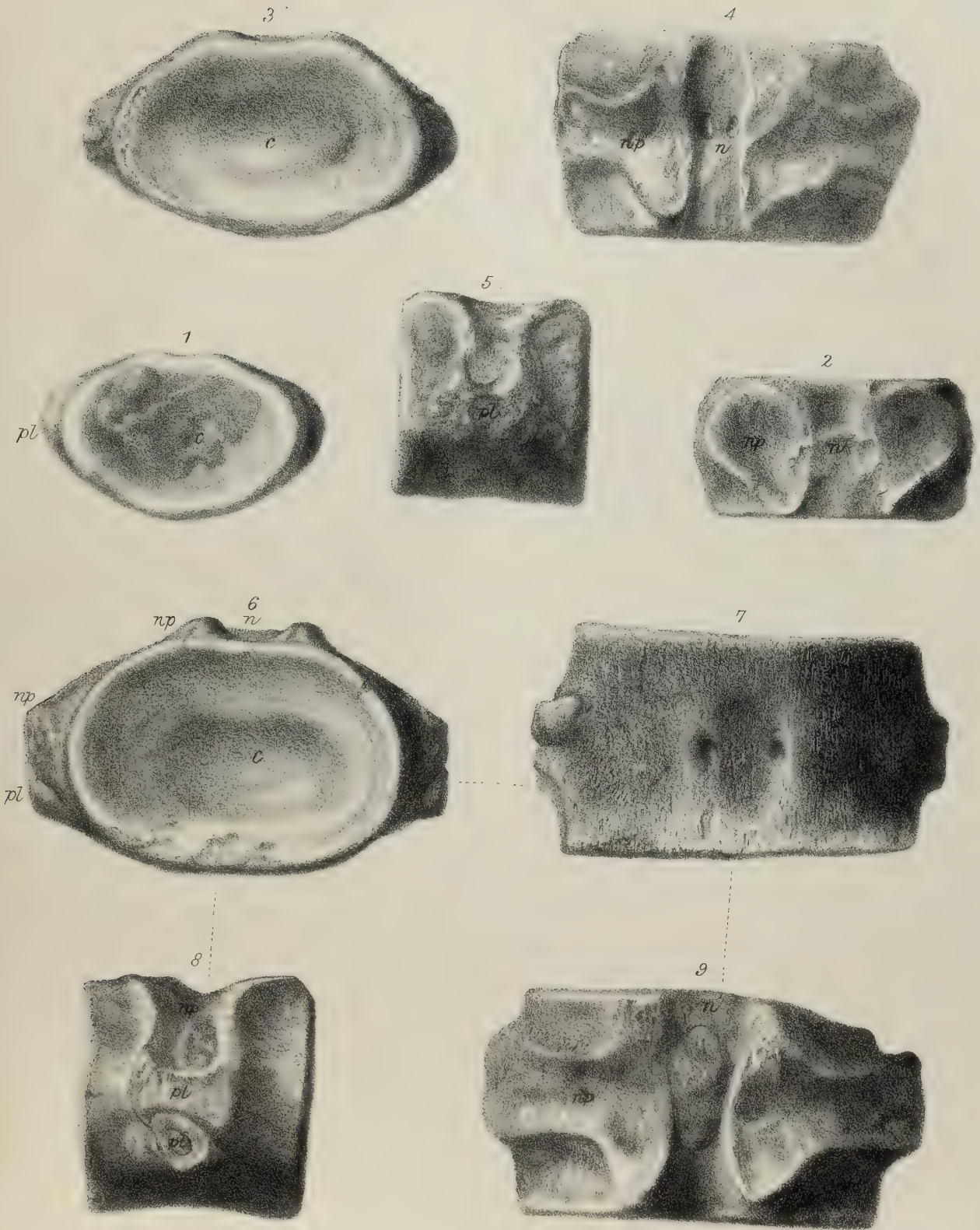
TAB. II.

Plesiosaurus planus, nat. size.

Fig.

1. Front view of centrum of posterior cervical vertebra.
2. Upper view of ditto.
3. Front view of centrum of posterior cervical vertebra of a larger individual.
4. Upper view of ditto.
5. Side view of ditto.
6. Front view of centrum of posterior cervical vertebra of a larger individual.
7. Under view of ditto.
8. Side view of ditto.
9. Upper view of ditto.

From the Upper Green-sand near Cambridge. In the Woodwardian and British Museums.



J. Dinkel del. et lith.

PLESIOSAURUS PLANUS.

W West imp.

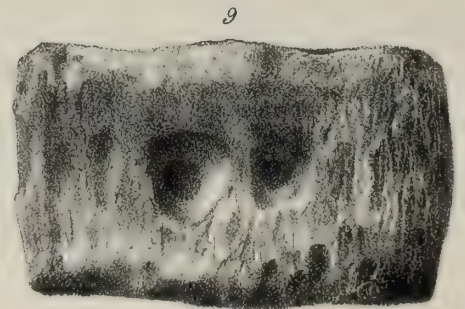
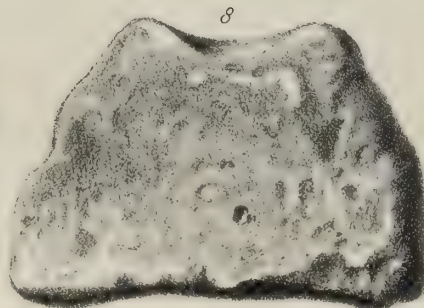
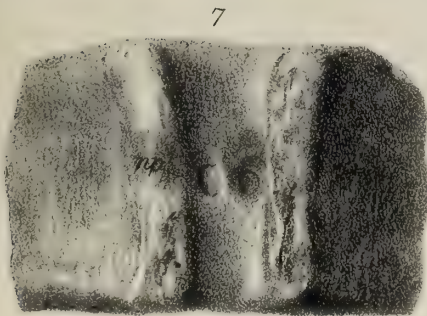
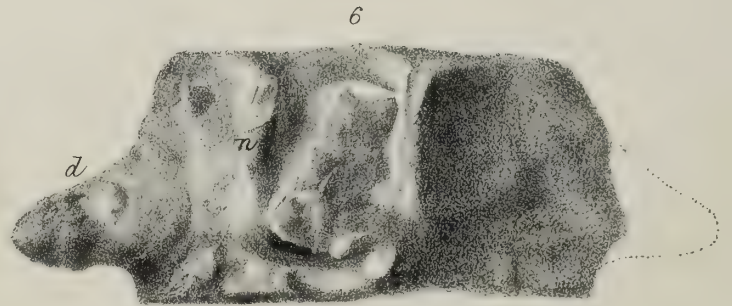
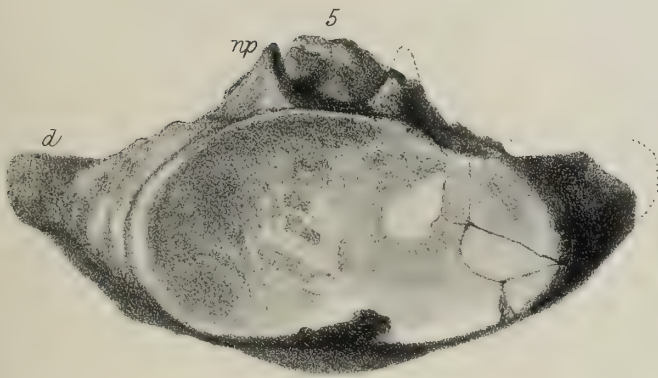
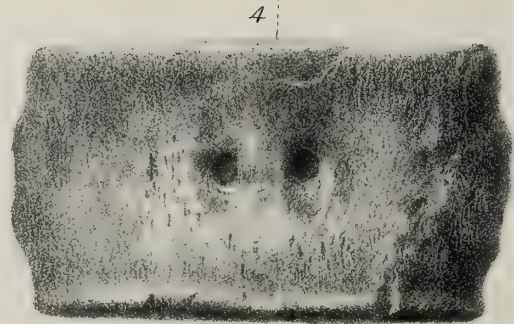
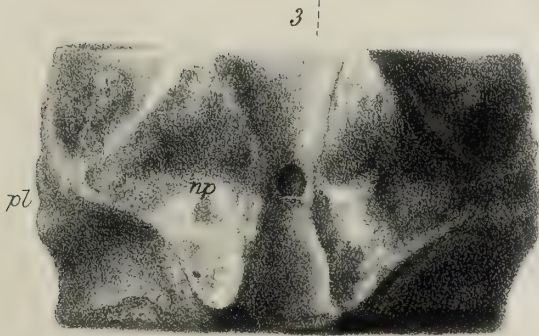
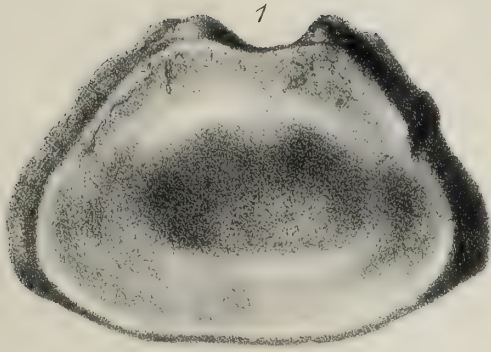
TAB. III.

Plesiosaurus planus, nat. size.

Fig.

1. Front view of a centrum from near the posterior part of the neck.
2. Side view of ditto.
3. Upper view of ditto.
4. Under view of ditto.
5. Front view of centrum of posterior cervical vertebra.
6. Upper view of ditto.
7. Upper view of anterior cervical vertebra, from an individual much larger than the one to which the vertebra, Tab. I, figs. 1—4, belonged.
8. Front view of ditto, with the surface abraded.
9. Under view of ditto.

From the Upper Green-sand, near Cambridge. In the Woodwardian and British Museums.



J Dinkel del et lith.

PLESIOSAURUS PLANUS; figs 1.....4, 7.....9, var. trigonalis.

W. West imp

TAB. IV.

Plesiosaurus Bernardi, nat. size.

Fig.

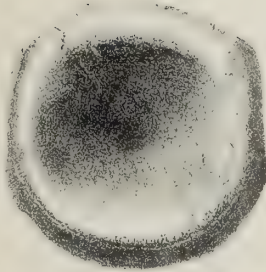
1. Side view of centrum of an anterior cervical vertebra.
2. Front view of ditto.
3. Upper view of ditto.
4. Under view of ditto.
5. Side view of centrum of a cervical vertebra.
6. Front view of ditto.
7. Side view of centrum of cervical vertebra, slightly distorted by posthumous pressure.
8. Front view of ditto.
9. Side view of centrum and base of neural arch of cervical vertebra.
10. Side view of centrum and base of neural arch of a succeeding cervical vertebra.
11. Side view of centrum and neural arch, *minus* spine, of a cervical vertebra of a larger individual.

From the Upper Green-sand, near Cambridge. In the British Museum.

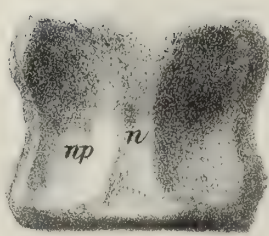
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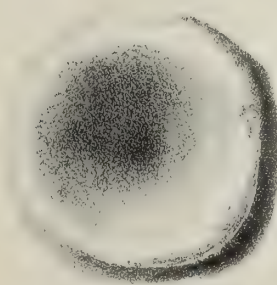
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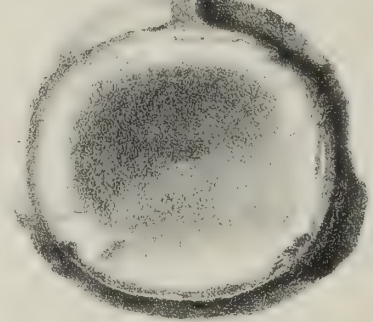
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10



J. Dinkel del et lith

PLESIOSAURUS BERNARDI

W West imp

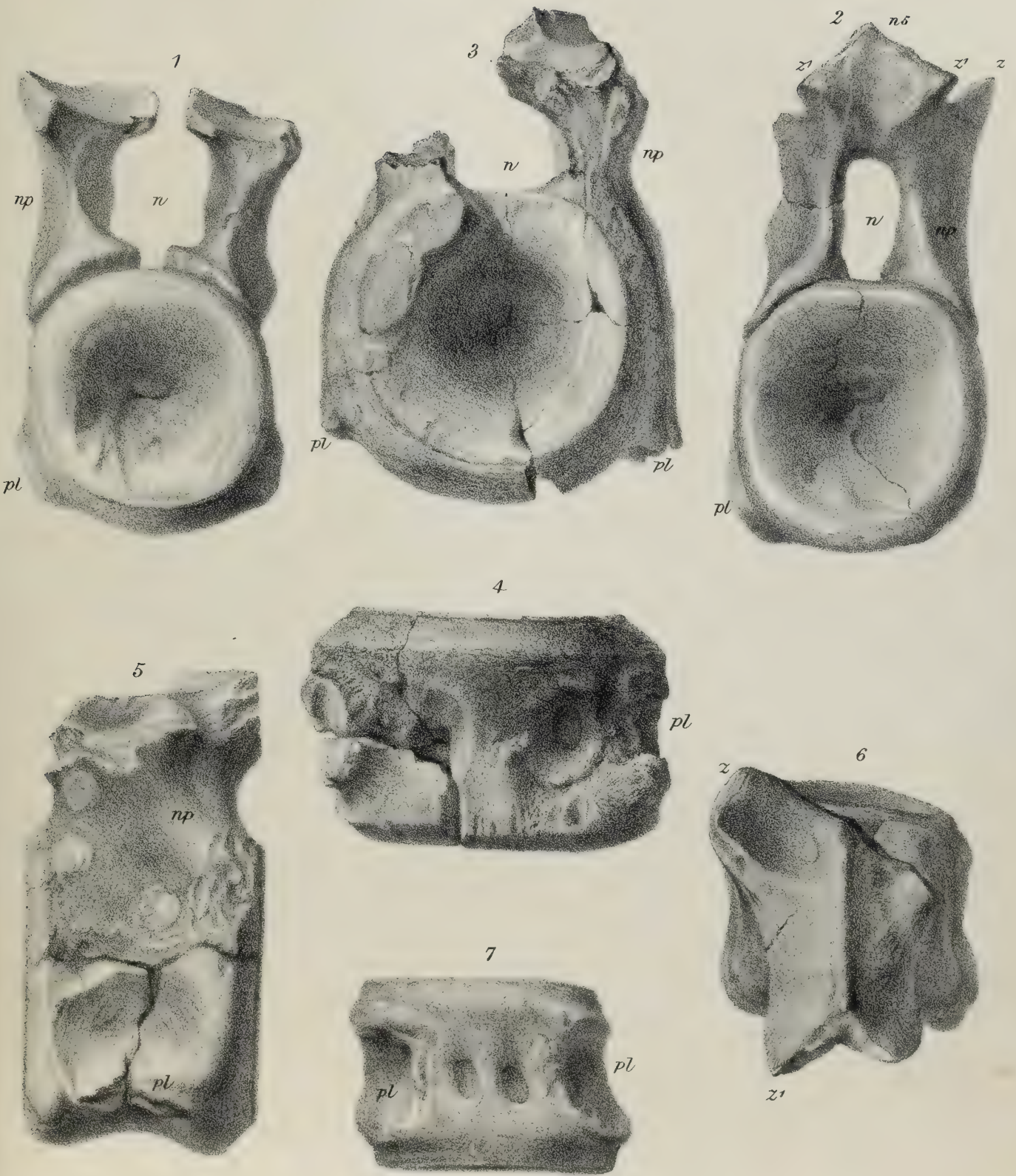
TAB. V.

Plesiosaurus Bernardi, nat. size.

Fig.

1. Front view of centrum and neurapophyses of cervical vertebra.
2. Back view of centrum and neural arch, *minus* spine, of cervical vertebra.
3. Front view of centrum and anchylosed base of neural arch of cervical vertebra of a larger individual.
4. Under view of ditto.
5. Side view of ditto.
6. Upper view of the vertebra, fig. 2.
7. Under view of centrum of cervical vertebra, slightly distorted by posthumous pressure.

From the Upper Green-sand, near Cambridge. In the British Museum.



J. Dinkel del. et lith.

W. West imp.

PLESIOSAURUS BERNARDI.

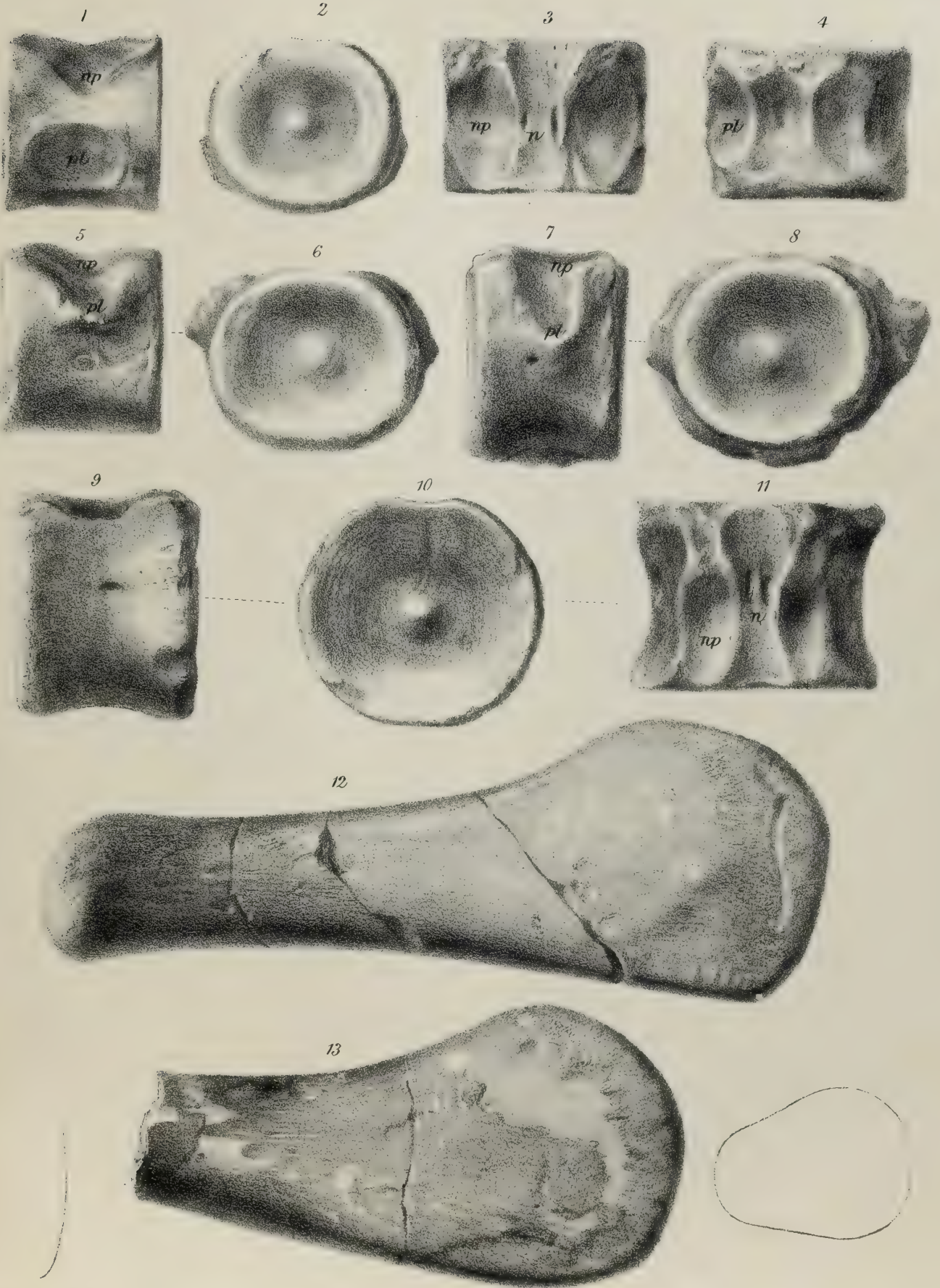
TAB. VI.

Plesiosaurus neocomiensis, Cpche., nat. size.

Fig.

1. Side view of centrum of cervical vertebra.
2. Front view of ditto.
3. Upper view of ditto.
4. Under view of ditto.
5. Side view of centrum of a posterior cervical vertebra.
6. Front view of ditto.
7. Side view of centrum of last cervical vertebra.
8. Front view of ditto.
9. Side view of centrum of a dorsal vertebra.
10. Front view of ditto.
11. Upper view of ditto.
12. Femur, side view, with outline of distal end.
13. Lower part of humerus, with sectional contour of the expanded portion.

From the Upper Green-sand, near Cambridge. In the Woodwardian and British Museums.



J. Dinkel del et lith

PLESIOSAURUS NEOCOMIENSIS, Cpche

W. West imp

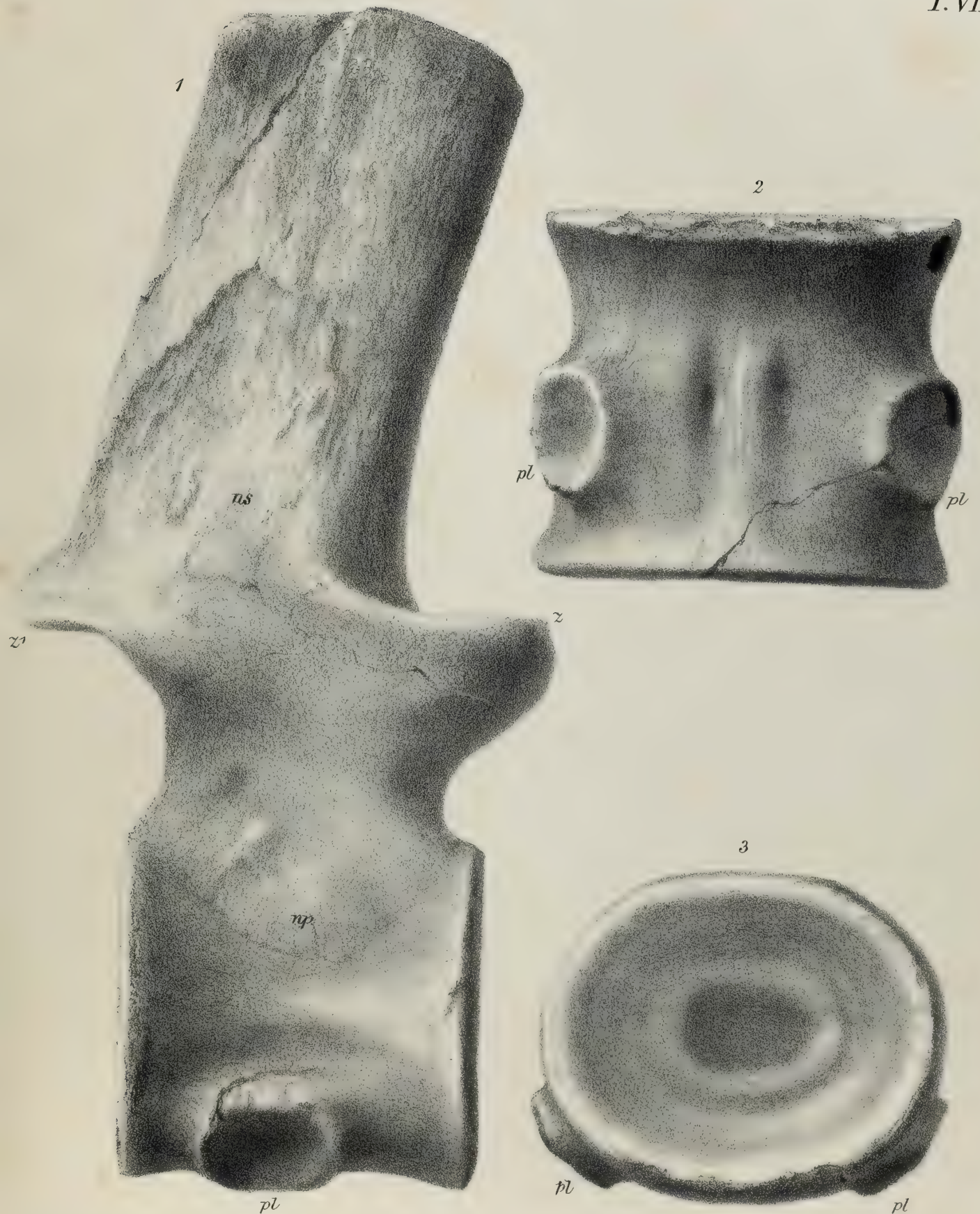
TAB. VII.

Plesiosaurus latispinus, nat. size.

Fig.

1. Side view of centrum of cervical vertebra.
2. Under view of ditto.
3. Front view of ditto.

Discovered by Mr. W. H. Bensted in the Lower Green-sand of the Iguanodon Quarry, near Maidstone; now in the British Museum.



J. Dinkel del. et lith.

W. West imp.

PLESIOSAURUS LATISPINUS.

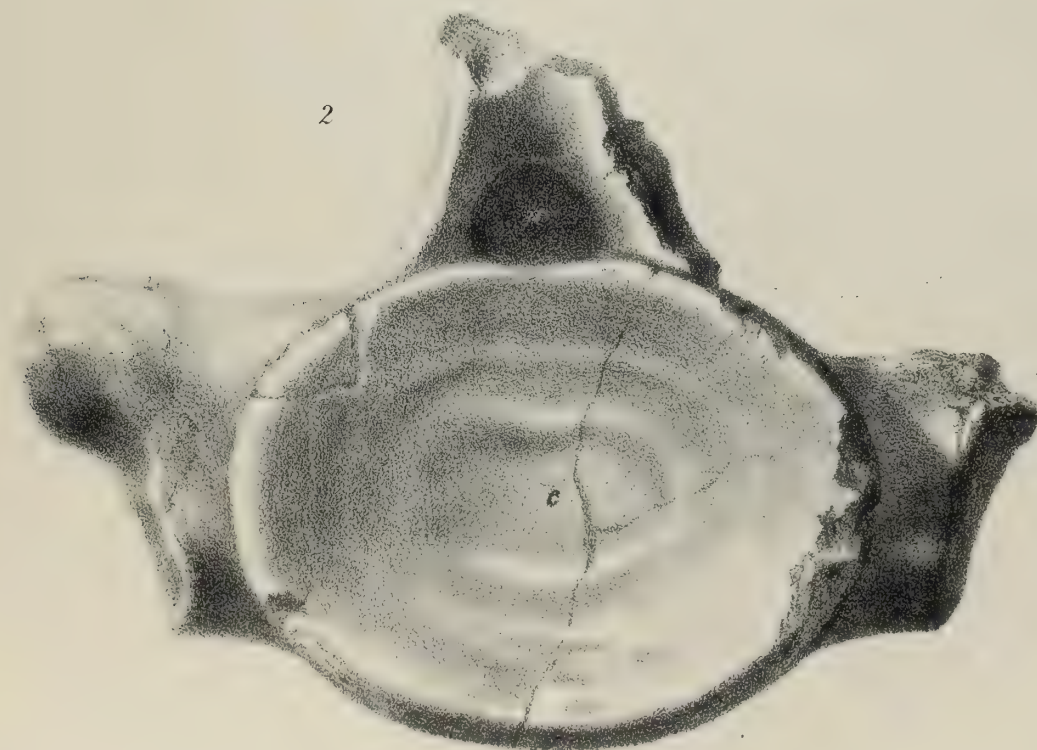
TAB. VIII.

Plesiosaurus latispinus, nat. size.

Fig.

1. Side view of centrum and part of anchylosed neural arch of a posterior cervical vertebra.
2. Back view of ditto.
3. Front view of centrum and anchylosed neural arch, mutilated, of a dorsal vertebra.

Discovered by Mr. W. H. Bensted in the Lower Green-sand of the Iguanodon Quarry, near Maidstone ; now in the British Museum.



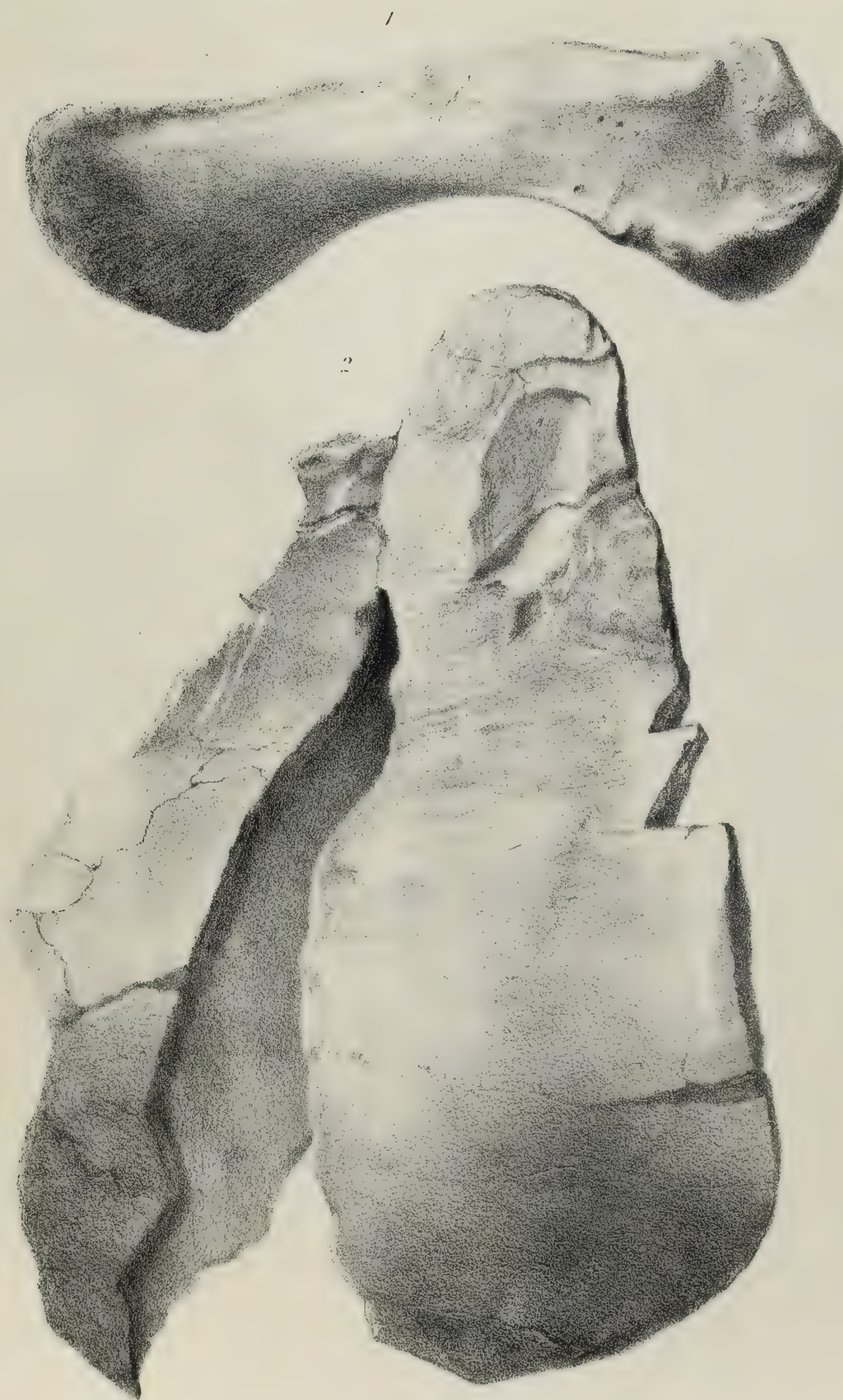
TAB. IX.

Plesiosaurus latispinus, nat. size.

Fig.

1. Right iliac bone.
2. Portion of left coracoid bone.

Discovered by Mr. W. H. Bensted in the Lower Green-sand of the Iguanodon Quarry; now in the British Museum.



TAB. X.

Iguanodon Mantelli, nat. size.

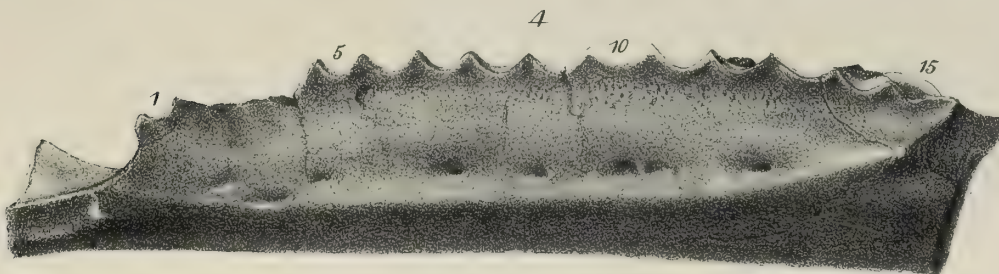
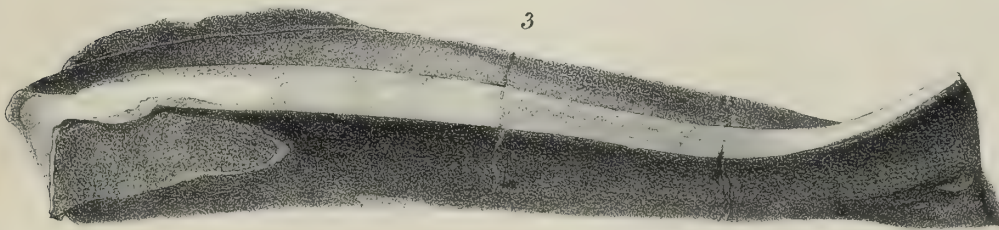
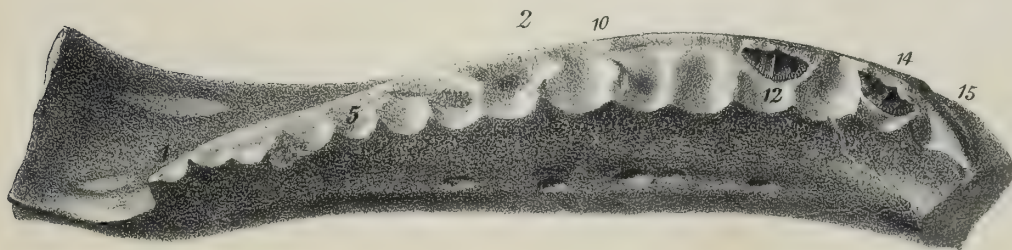
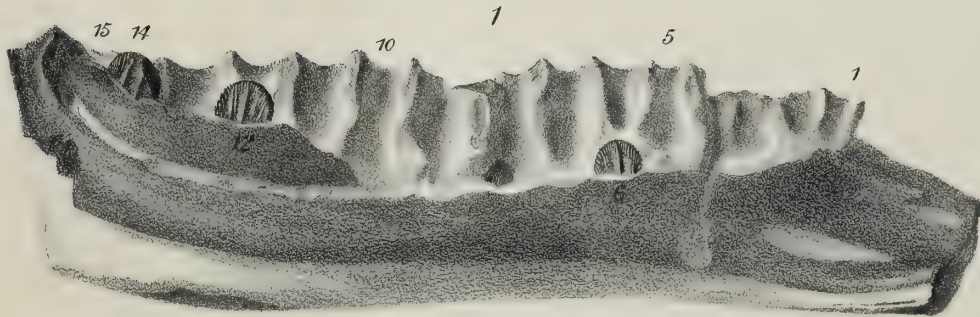
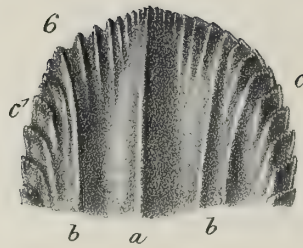
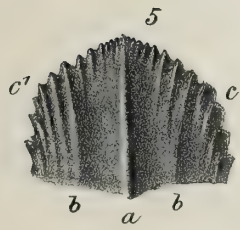
Fig.

1. Inner side of part of the left mandibular ramus, showing part of thin inner alveolar wall (12), of a young *Iguanodon*.
2. Upper view of ditto.
3. Under view of ditto.
4. Outer side of ditto.

In each figure, 1 to 15 indicate the alveolar depressions in the outer wall.

5. Inner side of apex of crown of the successional tooth (6, fig. 1), magnified.
6. Inner side of apex of crown of the successional tooth (12, fig. 1), magnified.

Discovered by the Rev. W. Fox, M.A., in the Wealden, near Brixton, Isle of Wight.



J. Dunkel del. et lith.

W. West imp.

YOUNG IGUANODON

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OF THE
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1864—5.

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The number of copies of the Society's publications shall be limited to the number of Members, unless otherwise directed by the Council.

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VI.

The accounts of the receipt and expenditure of the Society shall be examined annually by two Auditors appointed by the Council; the Auditors to be Members of the Society, who are not Members of the Council, and their statement circulated among the Subscribers.

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a Index. b Title-page to Univalves. c Note to Crag Mollusca. d Contains the Permian, which is complete. e Two corrections of Plates.
f Supplement. g Many of the Species are described, but not figured. h British Species only reckoned. i British Species only reckoned.

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